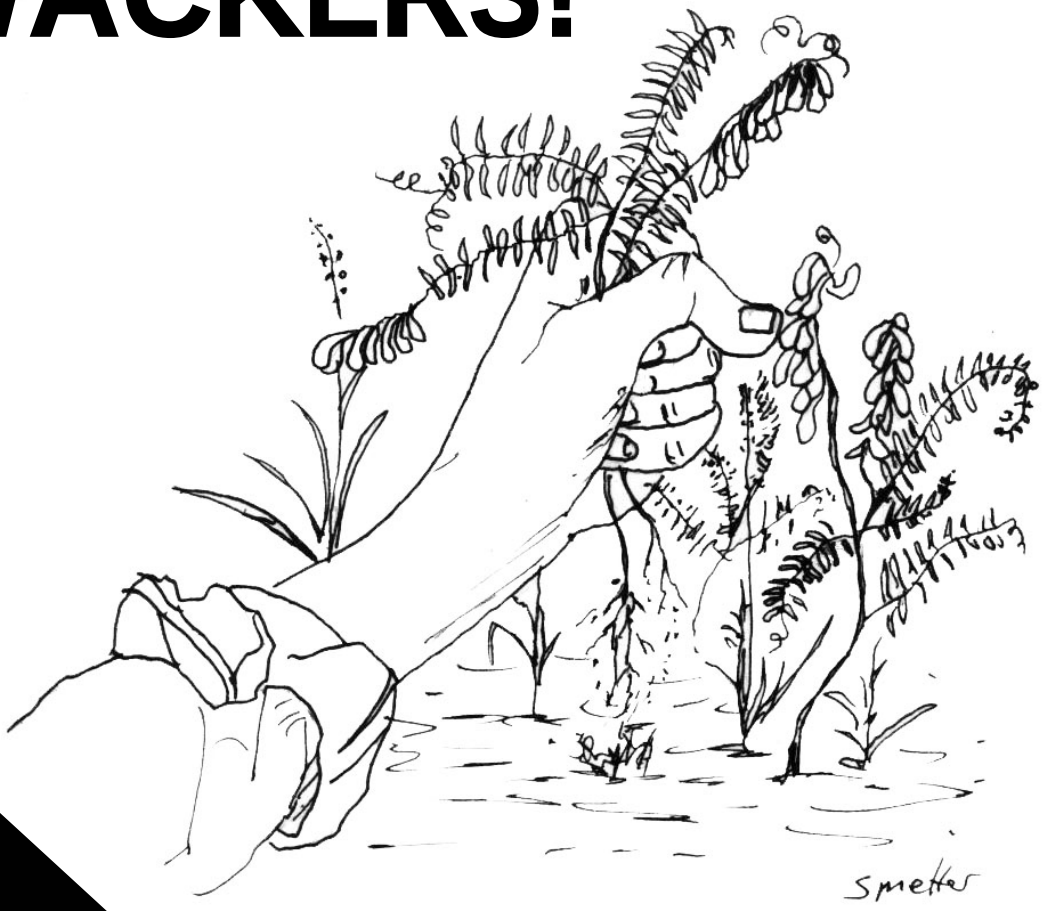
WEED WACKERS!



K-6 Educators Guide to Invasive Plants of Alaska

By Katie L. Villano
and Christine P. Villano

WEED WACKERS!

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October 2008
Fairbanks, Alaska

With Generous Support from:

Salcha-Delta Soil and Water Conservation District

UAS

Schoolyard LTER

Bonanza Creek LTER

Center for Global Change & Arctic System Research

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For more information contact
Christine Villano or Katie Villano,
2142 Bridgewater Dr., Fairbanks, AK, 99709
(907) 452-6765
cvillano@northstar.k12.ak.us or kvillano@alaska.edu

Access this manual and companion slideshows online at
http://weedwackers.wikispaces.com

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Acknowledgements

Authors: **Katie Villano**, University of Alaska Fairbanks, Institute of Arctic Biology
Christine Villano, Fairbanks North Star Borough School District, Denali Elementary School

Illustrators: **John P. Smelter**, University of Alaska Fairbanks, School of Fine Arts
Erin Anderson, University of Alaska Fairbanks, School of Fine Arts
Katie Villano, University of Alaska Fairbanks, Institute of Arctic Biology

Pilot Teachers: **Christine Villano**, Fairbanks North Star Borough School District, Denali Elementary School
Deana Martin-Muth, Fairbanks North Star Borough School District, Denali Elementary School
Katie Villano, University of Alaska Fairbanks, Institute of Arctic Biology

Reviewers: **Helen Cortés-Burns,** University of Alaska Anchorage Alaska Natural Heritage Program
Gino Graziano, Alaska Association of Conservation Districts
Kristi Kantola, Conservation Education Specialist, USDA Forest Service
Dr. Christa Mulder, University of Alaska Fairbanks, Institute of Arctic Biology
Stephanie Rudig, Fairbanks North Star Borough School District
Dr. Elena Sparrow, University of Alaska Fairbanks International Arctic Research Center
James Villano, Fairbanks North Star Borough School District

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Publication: **Katie Villano**, University of Alaska Fairbanks, Institute of Arctic Biology

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Preface

Biological invasions are a key element in global change (Vitousek et al. 1997). Invasive species are among the top causes of losses in native biodiversity worldwide (Sala et al. 2000), and play a role in the imperilment of nearly half the extinct and endangered species in the U.S. (Wilcove et al. 1998). Due to the vast undeveloped areas of the state, Alaska has remained relatively less affected by invasive species than the rest of the United States. In the contiguous states and Hawaii, few areas are left that have not been disturbed by humans and invaded by exotic species (Shephard 2004). In order to protect our unique Alaskan biodiversity and prevent invasion-mediated change in Alaska, it is essential that we educate Alaska's youth about the growing issue of invasive plants in Alaska.

"We hope that WEED WACKERS will reach thousands of Alaskan students at their most impressionable ages, and inspire them to go from the classroom to teach their families about invasive plants."

Up until five years ago, factors such as climatic constraints on invasive plant growth and minimal human disturbance had led land managers and researchers to believe Alaska's boreal ecosystems were relatively impenetrable to invasives (Shephard 2004). It has become increasingly apparent, however, that Alaska is not immune to exotic plant invasions. Warming climate (longer growing seasons, warmer winters and increased natural disturbances) and increased human disturbance (increased transport, road construction and maintenance) have increased the likelihood of invasive species spread throughout the state. Alaska's non-native plants have largely been restricted to human population centers and roadsides (Shephard 2004). Several species, however, have recently established and spread into areas of natural disturbances adjacent to roads such as wildfire scars (Cortes-Burns et al. 2007; Villano 2008) and glacial river floodplains (Wurtz et al. 2006). Alaska appears to be at the start of the invasion process that occurred in the rest of the United States about five decades ago (Carlson and Shephard 2007).

Alaska is in the unique position to take preventative measures against invasive outbreaks in our pristine ecosystems. To protect our unique native plant communities we must control existing invasive plant populations in places where they are likely to spread into natural areas and reduce the influx of invasive plants in developed areas (Carlson and Shephard 2007). The most cost-effective way to achieve these imperatives is through continued research and education on invasive plants in Alaska, both informing precise control efforts and building public awareness and cooperation.

This educator's guide will focus on three primary themes important to understanding and preventing invasive

spread in Alaska: 1) Identify and investigate non-native and invasive plants in boreal and arctic ecosystems; 2) Explore the interactions between invasive plants and our native ecosystems, including the impacts invasive plants can have on Alaskan vegetation and wildlife, and the role climate change might have on invasive plant spread; and 3) Realize the role society plays in the spread of invasive plants, including the potential for Alaskan youth to help reduce invasive plant spread and protect our unique habitats.

Our hope was to provide teachers with lessons that allow then to teach about plants and ecosystems, two important content strands in the Alaska State Life Science Standards, in a new, exciting, and meaningful way. The lessons in this unit of study allow students to be active citizen scientists, problem solvers, and participants in conservation efforts. In addition, our guide aims to fill a void in classroom materials available on this growing issue in Alaska and bring the Alaska Committee for Noxious and Invasive Plant Management a step closer to achieving their strategic goal of widespread K-12 invasive plants education in the state.

We hope that *WEED WACKERS* will reach thousands of Alaskan students at their most impressionable ages, and inspire them to go from the classroom to teach their families about invasive plants. We know that the children of today will create the attitudes of tomorrow, and will continue to decide to preserve and protect Alaska's wild places.

-Katie Villano and Chris Villano, 2008

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Why Use *WEED WACKERS*?

Invasive plants are a rapidly growing issue in Alaska. Education is the key to preventing new species from establishing in Alaska and reducing the spread of the species already here. WEED WACKERS is designed to be an Alaska-specific resource for teachers to integrate the study of invasive plants in their classrooms. Because the issue of invasive plants is such a new issue in our state, teachers implementing these lessons in their classroom are at the forefront of conservation education in Alaska. Students will conduct research that is on the cutting edge of this topic. The information they obtain will be relevant and useful to our state and communities, and should be shared with the community of researchers, land managers and experts trying to tackle the issue of invasive plants across the state.

In Unit 1, Alaskan teachers and students will become familiarized with invasive and non-native plant species currently in Alaska. The lessons will help students define the problem of invasive plants and explore questions relevant to halting the spread of invasive plants in Alaska. Which plant species are non-native and invasive in the state? How can we identify them? Why do we care about invasive species? How can invasive plants impact Alaskan habitats? A variety of activities in this unit will help students address these questions and set the stage for further experimentation and exploration of invasive plants.

In Unit 2, students will conduct meaningful, cutting edge research in experiments adapted from current University of Alaska experiments. The classroom inquiries in this unit investigate questions that are only beginning to be studied in Alaska's unique ecosystems. For example, in the lesson "Weed Seeds and Alaska's Changing Climate" students investigate the question "What is the relationship between a warmer winter climate and invasive plant establishment in Alaska?" In a series of three lessons on the relationship between invasive plants and disturbance, students have the opportunity to investigate the question "Will increasing fires in Alaska promote invasive plant spread?" This question becomes ever more relevant as the warming summer temperatures in Alaska create drier, more flammable forests. In two *WEED WACKERS* experiments, students will compare germination and competitive abilities of a variety of Alaska's native and invasive plants species helping to gain valuable evidence in the current quest to answer the question "Will invasive plants alter boreal and arctic tundra plant communities?" Students will be immersed in current ecological puzzles and will help fill the information gap on invasive plants in Alaskan ecosystems.

Figure 1. A fifth grader and first grader show a teacher their field observations in WEED WACKERS lesson 12.

In Unit 3, students explore the relationships between human society, culture and invasive plants in Alaska. As Alaskans, we depend on many non-native plant species, and introduce them either on purpose or by accident for agricultural or ornamental purposes. Not all non-native plants are able live in Alaska without the help of humans. However, some non-native plant species can live on their own, or become naturalized, and some can become invasive and spread out of control. Human activities facilitate the spread of invasive plants throughout Alaska. Unlike any other state in the U.S., we are only at the beginning of the invasion process and still have many wild areas that have never been touched by a human, let alone an invasive plant. If we act quickly and continue to educate our communities, we can help prevent the continued invasion.

The lessons in *WEED WACKERS* can inspire Alaskan youth to become advocates for the conservation of our natural resources and habitats and empower them to be civic leaders and scientists that will make a positive difference for Alaska.

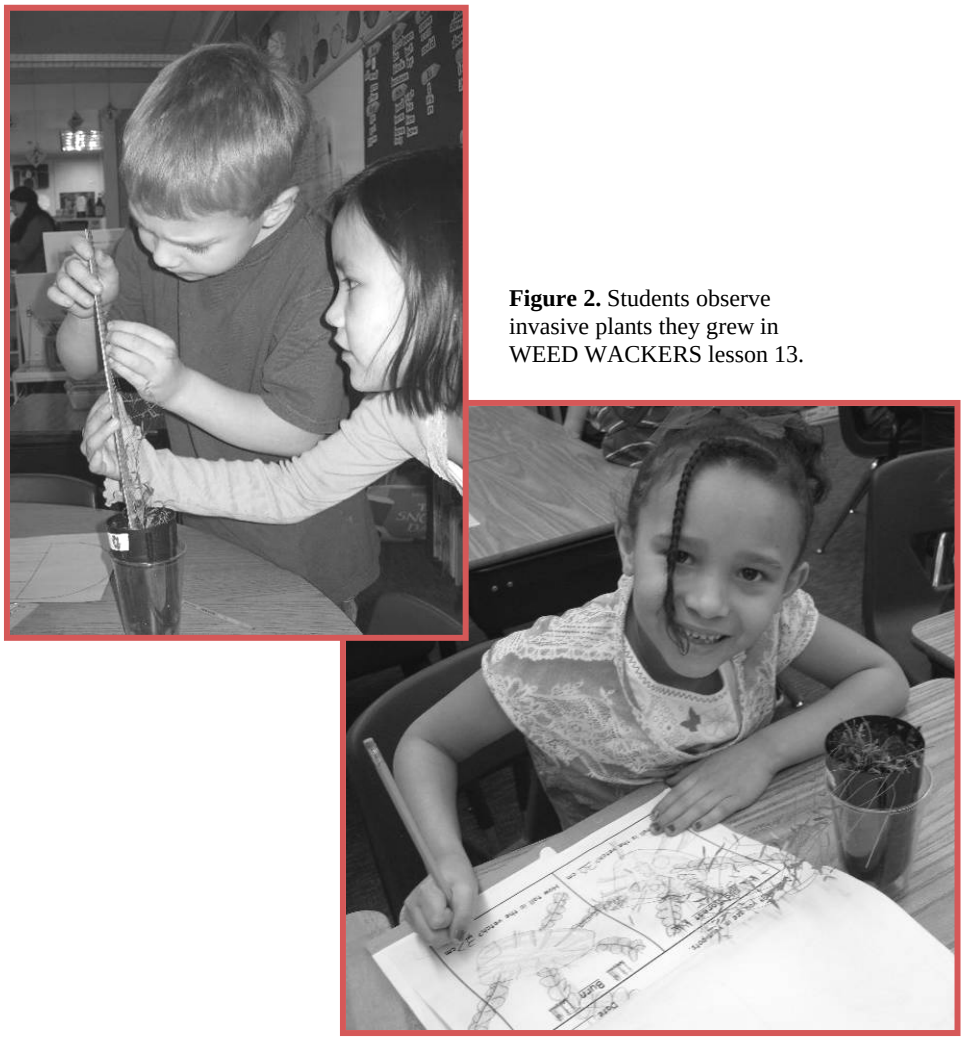


Figure 2. Students observe invasive plants they grew in WEED WACKERS lesson 13.

How to Use *WEED WACKERS*

Ideally the units and lessons in *WEED WACKERS* should be taught in sequence, building layers of information to the final lesson. However, teachers may also easily pick and choose lessons to use in their classrooms as time allows.

Lessons are adaptable to a variety of grade levels. If you are teaching older students and feel they need more foundational information, adapt lessons designed for younger students to your classroom. Many lessons are also adaptable to 7th and 8th grade classrooms.

Because teachers are often constrained by time, the need to teach other disciplines, and the need to meet mandated education standards, all *WEED WACKERS* lessons are designed to fit current Alaska State Science Standards, and to offer a cross-curricular, integrated approach to teaching about invasive plants. Combine regularly scheduled curriculum require-ments with the topic of invasive plants in Alaska. For example, teach SC1 requirements by having students investigate adaptations invasive plants use to thrive in Alaskan environments. *WEED WACKERS* lessons approach the topic of invasive plants not only through scientific inquiry, but through the integration of math, technology, language arts, social studies, art, and civics into a variety of lessons.

We are also aware of the diversity of students in Alaskan classrooms, and hope to provide opportunities in our lessons for students with varied learning styles and multiple intelligences by diversifying instruction with writing, art, dramatization,
songs, games, hands-on activities, and cooperative learning techniques.

About the Lessons

All lessons in WEED WACKERS are written in an inquiry style according to the Alaska Science Consortium Learning Cycle Model. The model can be applied to both lessons where students learn from primary and secondary resources, or in lessons where students learn from their own observations and experiments. Figure 3 illustrates the Alaska Learning Cycle Model and describes the steps involved in the process. For more information on how to use the Alaska Science Consortium Learning Cycle Model in your classroom visit http://www.akscience.org/lcm.html.

Lesson Sections

Each lesson includes the following sections:

Grade Level: Lists the grade level for which the lesson is suitable. Many lessons are adaptable to other grade levels.

Alaska State Science Standards: Lists the Alaska state science standards addressed by the lesson. Standards are listed with the standard number first. The grade level expectation is listed after the decimal point, and the grade level is listed within the brackets. No science standards exist in the State of Alaska for grades K-2, so these grade levels are not indicated in this section. National Science Standards for early primary do exist, however, and are quite similar to the objectives outlined for the older grade levels in the Alaska State Science Standards.

Subject: Lists one or more subjects that the lesson addresses, such as science, math, or language arts.

Target Skills: Lists the specific process skills of science that are addressed by the lesson. These skills are defined by the Alaska Science Consortium and are listed in Table 1.

Duration: Indicates the approximate time needed for each lesson, and the number of recommended class sessions. This recommendation can easily be adapted to the available time in your classroom.

Setting: Describes the setting for the lesson. Settings include classroom, schoolyard, open space (such as the playground or gymnasium), and field study sites.

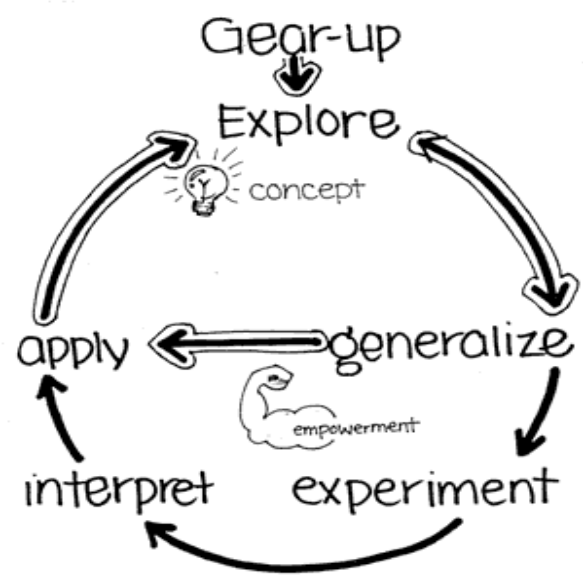
Vocabulary: Lists vocabulary words and key concepts associated with the lesson. Depending on the ability of your students, all vocabulary words many not be suitable for use during instruction.

Instructional Goal: Defines the concepts that students will understand by completing the lesson.

Performance Objectives: Provides an explanation of the specific performance expectations for the lesson. These are observable student behaviors, actions or products that demonstrate student mastery of the instructional goal.

Materials: Lists supplies needed to complete the lesson. Many of the materials needed for the lessons are included at the end of the lesson in the worksheets or can be found in the *WEED WACKERS* teaching materials kits that accompany this guide.

Figure 3. Alaska Science Consortium Learning Cycle Model (ASC 2008).



Gear-Up: Mentally engage and motivate students. This is an excellent time to gain information on students' preconceptions. Similar to "anticipatory set" or "engagement".

Explore: Hands-on, minds-on activities that provide an opportunity for the students to discover a new explanation for an event or concept.

Generalize: Teacher uses questioning strategies that help students to verbalize their new discoveries and identify questions to be tested.

Inquiry: Students design and conduct an experiment (a fair test).

Interpret: Students interpret and present the data or information that they have collected.

Apply: Students apply the newly learned concept. Activities should help the students to recognize the universal nature of the concept. (i.e. how does this concept operate in a context different than the one we just explored?). In *WEED WACKERS* the "Apply" phase of the Learning Cycle Model is the "Evaluation" section of the lesson.

Teacher Background: Provides background material for the teacher to prepare for the lesson. Some of the background material is complex, and is for the teacher benefit only. However, much of the material can be adapted and shared with students through discussion.

Advanced Preparation: Provides information on steps the teacher must complete to prepare the lesson.

Procedure: Describes the steps of the activity with ideas for each phase of the Alaska Science Consortium Learning Cycle Model.

Evaluation: Provides suggestions for assessing student learning and allowing students to apply concepts learned in the lesson.

Extensions: Includes additional ideas for further activities, or continuations of the activity in the lesson.

References: Lists references for teacher background material, classroom gear-up reading, websites, and publications used in each lesson. Several of the books and publications listed in this section are available in the *WEED WACKERS* teaching materials kits that accompany this guide.

Worksheets: These pages are designed for students to complete activities or experiments with. They include activity journals, activity worksheets, cards for games, and experiment observation notebooks for the teacher to copy and hand out to students. They can serve as evaluation tools for activities and help guide students through the inquiry process. Some lessons have two sets of worksheets for different literacy levels: emergent readers (Grades K-2) and proficient readers (Grades 3-6).

Collect seeds and plants to use in lessons!

Several lessons in Unit 2 call for invasive and native plant seeds to conduct experiments. The lessons "Weed Seed Germination," "Weed Seeds and Alaska's Changing Climate," and "The Great Plant Contest: A Competition Experiement," all require both invasive plant seeds and seeds from a native plant in the same family as the invasive. Please see these lessons for details and ideas for species to collect from. The lesson "Invasive Plants and Disturbance: Classroom Experiment" requires seeds from one invasive plant species. The first weeks of school in the fall are the perfect time to collect seeds. Make sure to collect only mature seeds. In general, mature seeds are not green and moist. Store seeds in a paper bag or envelope (not a plastic bag!) in a cool dry place until you are ready to conduct your experiments.

The Unit 1 lessons "Native or Non-Native" and "Invader Weapons: Roots, Leaves, Flowers and Seeds" require the use of pressed native and non-native plant specimens. You can have your students collect their own plants in the spring, summer, or fall. Press the plants and you can use them at any time during the year. Refer to the lesson "Native or Non-Native" for instructions on pressing plants. If plants are not available, pressed native and non-native plant specimens are available in the *WEED WACKERS* teaching materials kits that accompany this guide.

Table 1. The Process Skills of Science (ASC 2008)		
Skill	**Description**	**Instructional Prompts**
Observation	Using the five senses to obtain information about objects and events in our environment.	Observe. Feel. Smell. See. Taste. How much does it weigh? How tall is it? How did it change? What was the sequence of events?
Communication	Using oral or written words, diagrams, drawings, maps, graphs, and mathematics.	Describe. Name. Record. Construct. Graph. Draw. Share.
Classification	Creating order out of collections, objects or events by showing their similarities, differences and interrelationships.	Classify. Sequence. How are they alike? How are they different? How can you group these things?
Using Time/Space Relationships	Describing spatial relationships or how things change with time.	What shape? How did it move? How did it change? What was the rate of change?
Measurement	Observing objects, processes or events through direct measurement.	Measure. How much does it weigh? How long? What temperature? How many? How strong was the force? What was the rate?
Inference	Explaining or interpreting an observation.	Why do you suppose this happened? From what you have observed, what can you infer or assume? From what you know, what do you think caused…?
Prediction	Making a specific forecast of a future occurrence based on past and present observations, measurements, and inferences.	What do you think will happen? What do you think will happen if you changed…? If this is so, then…?
Defining Operationally	Describing a step by step process in the context of student experiences.	Describe procedure or methods you took. How did you do that?
Interpreting Data	Drawing conclusions based on measurements and observations. Interpretations may be used for further inferences, predictions, or hypotheses.	What do your measurements tell you? Which is taller? Which performs better?
Naming/Controlling Variables	Describing factors of an experiment that can be changed, and which factors should be held constant in order to isolate and test a single variable.	What factors could affect your results? Which factors were kept the same across treatments? Which factors varied across treatments?
Formulating Hypotheses	Creating testable generalizations based on observations or inferences.	What do you think will happen when you test the effects of …? Which group will do better and why?
Experimentation	Applies all other process skills to test a hypothesis and draw conclusions.	Experiment. Manipulate. Investigate. Conduct an inquiry. Test the effect of…

Introduction

What is an invasive plant?

An invasive plant is a type of non-native plant that was introduced intentionally or unintentionally by humans, became naturalized, and has the potential to spread rapidly. Most invasive plants in North America and Alaska originally came from Europe or Asia. In the ecosystems where plants evolve and adapt, herbivores, pathogens, and other factors, keep their populations in balance with the other organisms that live there. When the plants are transported away from their place of origin, they often escape many of the pressures that kept them in check. In the new habitat, they can become invasive, spreading rapidly, and out-competing native plant species.

Why do we care about invasive plants?

Invasive plants have the potential to harm many things that humans value, such as biodiversity, economics, and the aesthetic or cultural properties of the land. Invasive weeds threaten biodiversity, and can even cause local extinctions (extirpations) of rare or endangered species. In the U.S. alone, invasive species have played a role in the imperilment of nearly half the extinct and endangered species (Wilcove et al. 1998). Invasive weeds cost us over $34,000,000,000 dollars per year in the United States to manage and remove (Pimentel et al. 2000). Invasive weeds interfere with the crop and livestock production that we depend on for food. They can change habitats, disrupt food webs, and negatively impact wildlife. Some invasive plants, like cheatgrass, can make fires occur more frequently (D'Antonio 2000). Invasive weeds also negatively impact ecosystem services to humans (i.e. aesthetics, recreation, economics, health).

In Alaska, we have the rare opportunity to prevent many of these devastating impacts before they happen. Few areas are left in the contiguous states and Hawaii that have not been disturbed by humans and invaded by exotic species (Shephard 2004). In Alaska, however, we still have large amounts of undeveloped wilderness areas that have not been exposed to the damaging effects of invasive plants.

How did invasive plants get to Alaska?

On the North American continent, Alaska and the northern Canadian territories are truly the last frontier for invasive plants. Many were introduced by accident, and hitch-hiked to Alaska from the more southerly parts of the continent in cars, planes, ballasts of ships, and on the soles of shoes. Some invasive plants sneak up to Alaska hidden as seeds in bales of straw and hay, or in the soil sold with starter plants at national chain stores (Conn 2006). Many invasive plant species in Alaska were introduced on purpose, with good intentions. Japanese knotweed (*Polygonum cuspidatum*) was first introduced as a decorative plant, and it is now spreading in Southeast Alaska (ANHP 2005). Bird vetch (*Vicia cracca)* was first introduced to Alaska as a potential forage crop for Alaska. Bird vetch has begun to spread rapidly throughout the state. Once an invasive plant has become naturalized in Alaska, it can continue to be spread by wind, water, animals, equipment, vehicles, virtually anything that moves!

Why do invasive plants succeed?

Invasive plant species tend to be very good colonizers, able to tolerate a broad range of climates and soil conditions. They are all opportunistic species, tending to thrive especially well after disturbances. After a disturbance, competition from native plants is reduced and resource availability is increased. Ecologically, invasive plants are pioneer species. As with most pioneer species, invasive plants have adapted a variety of reproductive strategies that give them advantage over other plant species. Most invasive plants have lots of seeds, excellent dispersal, and tend to reproduce both sexually (with seeds) and asexually (with tillers, runners, stolons or rhizomes). In addition to reproductive advantages, many species of invasive plants have developed other strategies to out-compete native plant species such as large, rapidly growing shoots, leaves and roots to monopolize light, space, water and nutrients, allelopathy (chemicals secreted into the soil that deter the growth of other species), rapid and easy germination to grab space before native seedlings.

What can Alaskans do?

Alaska has the tremendous opportunity to prevent invasive plants from spreading into our vast wilderness areas. We must act now by educating our communities about the threat invasive plants pose to our ecosystems. Teach your students and empower them be activists on this important conservation issue. Here are few simple things that Alaskan's can do:

- Learn to recognize invasive plant infestations and avoid passing through them.
- Report any infestations to the local land manager.
- Check for seeds or plant parts and clean equipment, boots, animals, and gear between trips.
- Dispose of invasive plant seeds you find on clothing or equipment in a plastic bag in a trash can.
- Always use weed-free hay and feed for your animals.
- Avoid using invasive species in your garden, even if you live in an urban area!
- Don't use fill dirt from weedy sites and clean equipment before tilling or moving soil into your yard.
- Don't dig up roadside plants to plant in your garden unless you know they are native species.
- Volunteer to pull weeds.

With committed, educated citizens, Alaskans can prevent our habitats from being invaded.

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Lessons by Grade Level

#	Lesson Title	Grade Level							
		K	1	2	3	4	5	6	+
	Unit 1:								
1	Introduction to Plants	X	X	X	X	X	X	X	
2	Invasion in Alaska!?	X	X	X	X	X	X	X	
3	Weedy Definitions		X	X	X	X	X	X	
4	On the Case: Investigating Alaska's Alien Invaders		X	X	X	X	X	X	X
5	Native or Non-Native?				X	X	X	X	X
6	Invader Weapons: Roots, Leaves, Flowers and Seeds		X	X	X	X	X	X	X
7	Invasives in the Food Web		X	X	X	X	X	X	
	Unit 2:								
8	Weed Seed Germination		X	X	X	X	X	X	X
9	Weed Seeds and Alaska's Changing Climate		X	X	X	X	X	X	X
10	The Great Plant Contest: A Competition Experiment		X	X	X	X	X	X	X
11	New Territory for Weeds: Disturbance and Re-growth in Alaska's Forests	X	X	X	X				
12	Invasive Plants and Disturbance: Field Study		X	X	X	X	X	X	X
13	Invasive Plants and Disturbance: Classroom Experiment		X	X	X	X	X	X	X
	Unit 3:								
14	Not All Non-Natives Invade	X	X	X	X	X	X	X	X
15	Invasive Plant Management: A Race Against Time		X	X	X	X	X	X	
16	"Love the Weeds" Invasive Plants and Human Values						X	X	X
17	Community Perspectives on Invasive Plants						X	X	X
18	Weed Wear	X	X	X	X	X	X	X	X
19	Service Learning Weed Pull	X	X	X	X	X	X	X	X

Lesson Activities

#	Lesson Title	Activities
	Unit 1:	
1	Introduction to Plants	• Plant activity journal • Dandelion sequencing card activity
2	Invasion in Alaska!?	• "Invasion!" slide show • K-W-L Chart
3	Weedy Definitions	• "Weedy Definitions" fly swatter game
4	On the Case: Investigating Alaska's Alien Invaders	• "Invasive Plant Detective" research activity • "Bird Vetch: An Alaskan Invader" mini-book • Weed "WANTED" posters
5	Native or Non-Native?	• Plant collection and identification • Plant pressing • "Native or Not" relay race
6	Invader Weapons: Roots, Leaves, Flowers and Seeds	• "Invader Weapons" plant parts observation and inquiry • "Superweed" art activity
7	Invasives in the Food Web	• Food web construction and demonstration of invasive plant impacts
	Unit 2:	
8	Weed Seed Germination	• Invasive and native seed observation • Germination classroom inquiry
9	Weed Seeds and Alaska's Changing Climate	• Snow insulation observation • Germination and winter climate inquiry
10	The Great Plant Contest: A Competition Experiment	• Plant competition inquiry
11	New Territory for Weeds: Disturbance and Re-growth in Alaska's Forests	• Forest succession timeline dramatization
12	Invasive Plants and Disturbance: Field Study	• Transect field study

13	Invasive Plants and Disturbance: Classroom Experiment	• Soil core and plant growth classroom experiment
	Unit 3:	
14	Not All Non-Natives Invade	• Non-Native plant origins activity
15	Invasive Plant Management: A Race Against Time	• "Invasive plant control" slideshow • "Pull, Mow, Call and Spray" song • Invasive plant control story problem game
16	"Love the Weeds" Invasive Plants and Human Values	• "Love the Weeds" folktale • "Invasive Weed Values" Survey • Invasive plants and human values newspaper article discussion
17	Community Perspectives on Invasive Plants	• Mock city council meeting
18	Weed Wear	• T-shirt and garden glove design art activity
19	Service Learning Weed Pull	• Invasive plant pull • Flip-panel prediction and observation activity

Unit 1

Invasive Plants in Alaska

The lessons in this unit of *WEED WACKERS* are designed to familiarize Alaskan teachers and students with some of the species of invasive and non-native plant species currently found in Alaska. Which plant species are non-native and invasive in the state? How can we identify them? Why do we care about invasive species? How can invasive plants impact Alaskan habitats? Students will learn basic plant biology, important terminology for the study of invasive plants, how to identify native and non-native plant species, how invasive plants succeed, and the potential impacts that invasive plants can have on Alaskan habitats.

Lesson 1

Introduction to Plants

Grade Level: K-6
Alaska State Science Standards: SC1.1 [3,6], SC2.1[3-6], SC2.2 [3-6]
Subject: Science, Language Arts
Target Skills: observation, using space/time relationships, communication, classification
Duration: three 30 minute sessions
Setting: Classroom
Vocabulary: seed, germination, growth, pollination, fertilization, dispersal, roots, leaves, stem, and flower.

INSTRUCTIONAL GOAL ✦

Students will understand the basic life cycle of a plant and learn to identify basic plant parts.

PERFORMANCE OBJECTIVE ✦

Students will complete a plant journal with activities designed to introduce students to plants.

MATERIALS ✦

- *Dandelion* by Barrie Watts (grades K-2)
- *Incredible Plants* by Roger Carolin (grades 3-6)
- "How Do Plants Grow?" activity booklets
- Dandelion Sequence Cards
- Overhead transparencies
- Overhead projector

TEACHER BACKGROUND ✦

This lesson is designed to offer students a quick and basic understanding of plants. Mix and match the activity sheets in the "How Do Plants Grow?" booklet as appropriate for your classroom, your schedule, and the ability level of your students. The later lessons in this section of ***Weed Wackers*** will offer the students a more in-depth understanding of plant

processes through the study of a special kind of plants: non-native invasive plants.

Though the diversity of plants on our planet is enormous, there are some general themes to the study of plants. In this lesson, students will become familiar with the different phases of a flowering plant's life cycle: **seed, germination, growth, pollination, fertilization, and seed dispersal.** Students will need a basic understanding of the seed, germination, growth and seed dispersal phases of the life cycle for many of the later lessons in this unit of study. Pollination and fertilization of invasive plants will not be emphasized in this unit. In addition to understanding the life cycle of a flowering plant, this lesson also introduces students to the basic structural parts to a flowering plant: **roots, leaves, stem, and flower.**

ADVANCED PREPARATION ✦

- Xerox one copy of "How Do Plants Grow?" activity booklet for each student. Transfer each activity sheet to an overhead transparency to guide students through the activities.
- For grades K-2, make a copy of the "Dandelion Sequencing Cards" found in this lesson for every pair of students. Cards will be used to orally explain the life cycle of a plant in pairs.
- (Optional) K-2, laminate sets of dandelion life cycle pictures to be used as practice and review as a learning center activity

PROCEDURE ✦

Grades K-2

1. **(Gear-Up)** Read *Dandelion* by Barrie Watts aloud to the class. Encourage students to read the enlarged sentences at the top of each page along with you. Review the life cycle of the dandelion as a class. Make a list of all the plant parts the students saw in the book: stem, flower, bud, leaves, roots, seeds.

2. **(Explore)** Divide the students into pairs. Hand each pair a copy of the dandelion sequencing cards. Have pairs take turns telling each other the story of the dandelion life cycle using the pictures.

3. **(Generalize / Apply)** Have students use the information presented in the reading to complete the activities in the "How Do Plants Grow?" activity booklet. For early primary students eliminate more difficult pages from the activity booklet, such as the page "Pollination and Fertilization."
   -Guide students through the activities using the overhead projector.
   -Read new information at the top of each page aloud to the students.

4. **(Apply)** In pairs, have students cut out dandelion sequencing cards. Students take turns sequencing the cards on their own.

Grades 3-6

1. **(Gear-Up)** Read pages 6-15 in *Incredible Plants* by Roger Carolin aloud to the class.

2. **(Generalize)** Have students discuss in pairs new things they learned about plants from the reading. Students report back to the class new things that their partner shared with them.

3. **(Generalize / Apply)** Have students use the information presented in the reading to complete the activities in the "How Do Plants Grow?" activity

booklet. Guide students through the activities using the overhead projector, or allow students to work through the booklet independently.

4. **(Apply)** Have students write the life story of a plant from the perspective of their favorite plant. The story must include all phases of the plants life cycle, as well as mention all the plant parts included in the activity booklet (this includes the reproductive parts on the "Pollination and Fertilization" page). Here are some questions to get the story flowing:

   - What kind of plant are you?
   - When was your birthday? How do you know?
   - What was your first memory after germinating?
   - What did you need to grow? Did you have any struggles growing up?
   - What did it feel like being pollinated? Did it tickle? Were you pollinated by insects or the wind?
   - Do you have any features that you are proud of? Your beautiful flowers? Your strong roots?

EVALUATION ✦

- The completed "How Do Plants Grow?" activity booklet serves as one evaluation tool for this lesson.

- For K-2 students, have students color their dandelion sequence cards and paste them on a large sheet of construction paper in order in a circle. Students can label the stages after they sequence the pictures, or write a sentence to explain each stage of the cycle under each picture.

- For 3-6 grade students, the completed life story of a plant serves as an additional evaluation tool.

EXTENSIONS ✦

- Conduct a seed scavenger hunt in your schoolyard, garden, or nearby woods. Classify seeds by shape, color, or mode of dispersal.

- Collect plants from your schoolyard, garden, or nearby woods and use them to create crayon rubbing art murals.

- Sow dandelion seeds in soil and watch them germinate and grow in your classroom.

- Turn your classroom into a Plant Parts Café. Students sort commonly available fruits and vegetables by the part of the plant that we eat and then enjoy a feast. On the menu: flowers (broccoli, cauliflower), stems (celery, rhubarb, asparagus), roots (carrots, radishes), leaves (lettuce, cabbage, kale), and seeds (sunflower seeds, peanuts, green beans).

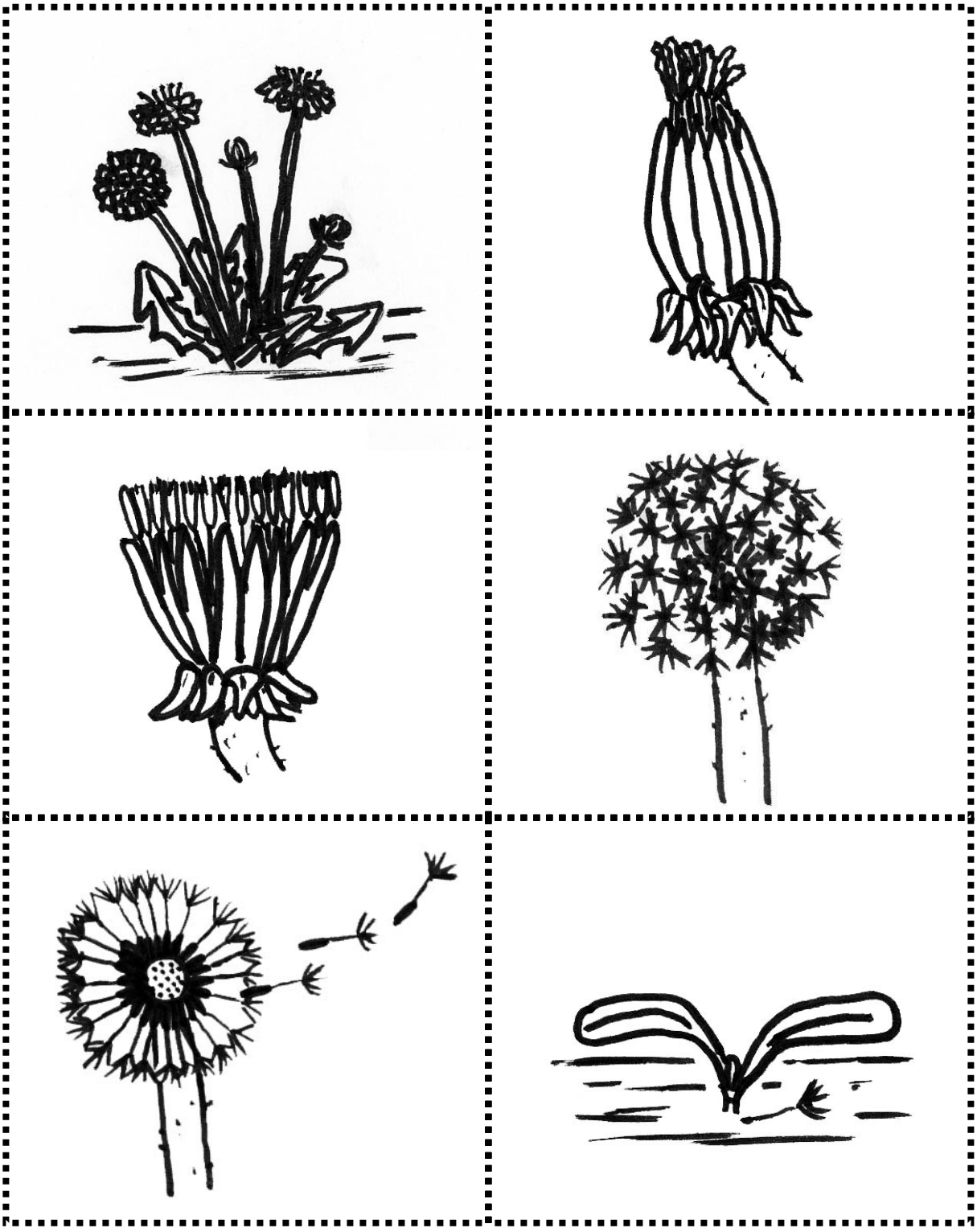
REFERENCES ✦

Alaska Department of Fish and Game (ADFG). 2005. Alaska Wildlife Curriculum, Alaska Ecology Cards. Anchorage, AK.

Carolin, R. 2005. *Incredible Plants*. Discoveries Series. Barnes and Noble Books, New York, NY.

Watts, B. 1987. *Dandelion*. Stopwatch Book Series. Silver Burdett Press, Englewood Cliffs, NJ.

Dandelion Sequencing Cards



How Do Plants Grow?

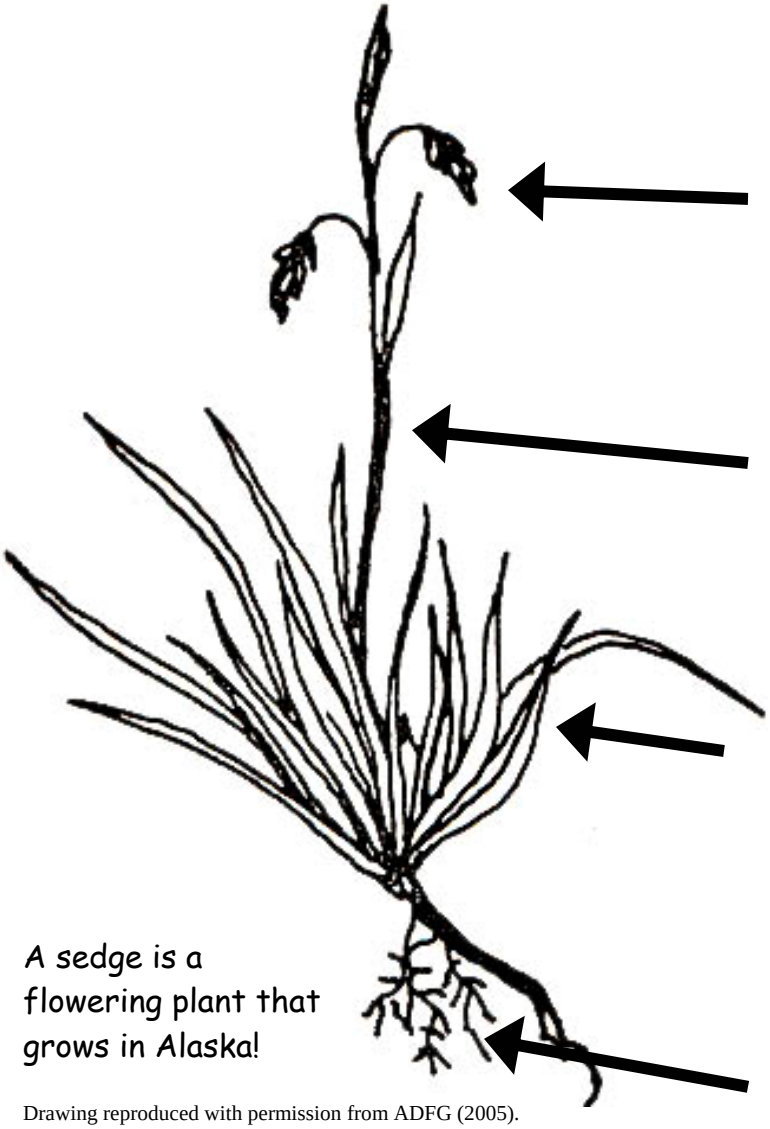
A Plant Activity Book

By _____

Parts of the Plant

Name the parts of the plant. Match and print the correct plant part word on the line next to the arrow.

leaf	root	stem	flower



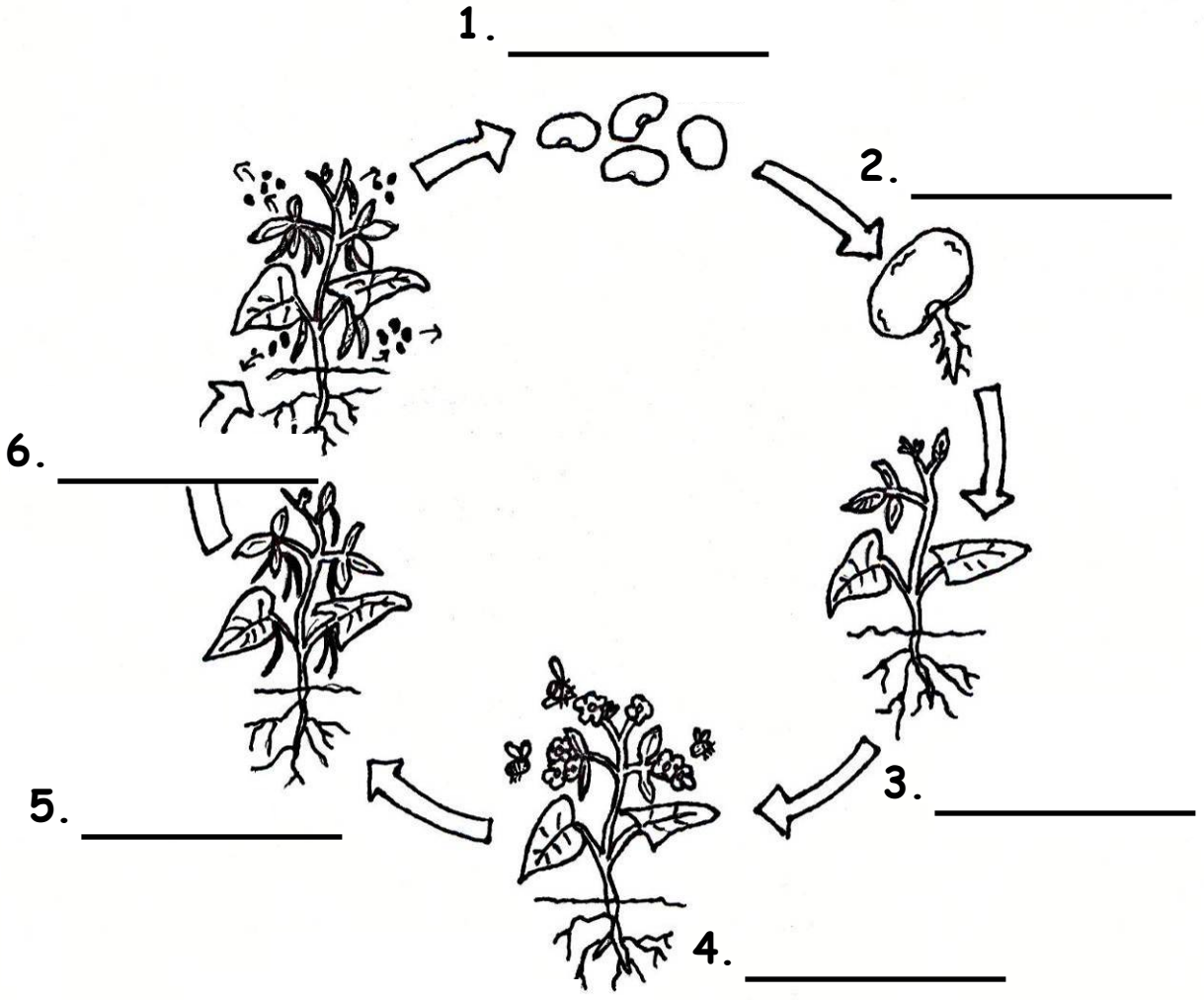
A sedge is a flowering plant that grows in Alaska!

Drawing reproduced with permission from ADFG (2005).

Plant Life Cycle

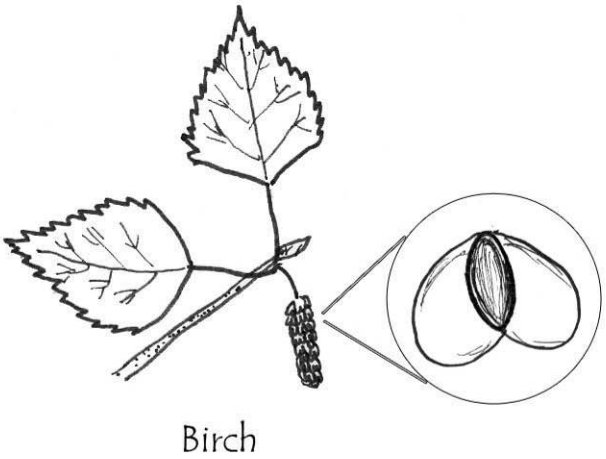
Plants have a life cycle, just like all living things. They begin as a seed, grow into a plant and then make new seeds. The life cycle for a flowering plant has 6 stages. **Use the words in the word box below. Print the name of the stage on the correct line.**

Fertilization	**Seeds**	**Pollination**
Seed Dispersal	**Growth**	**Germination**

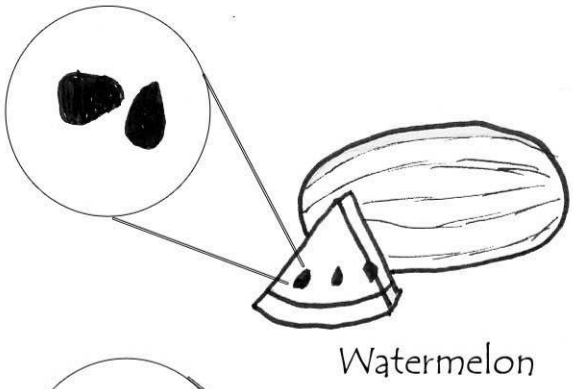


Seeds

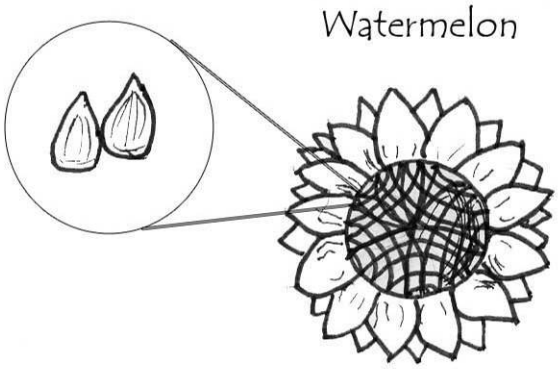
A seed is a baby plant waiting to happen. It holds food for the new plant once there is enough water and warmth for the seed to sprout. Seeds can survive over the winter, and even for many years! Seeds come in all shapes and sizes. They can be covered in shells, fruits, or cones. Color the seeds on this page.



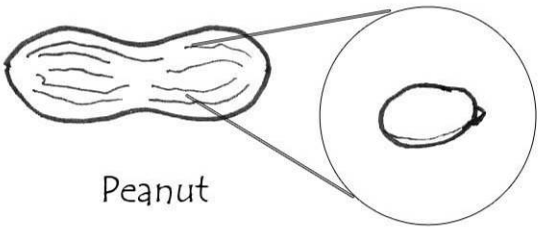
Birch



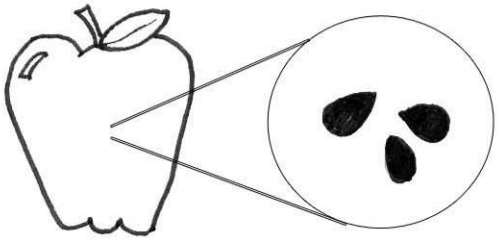
Watermelon



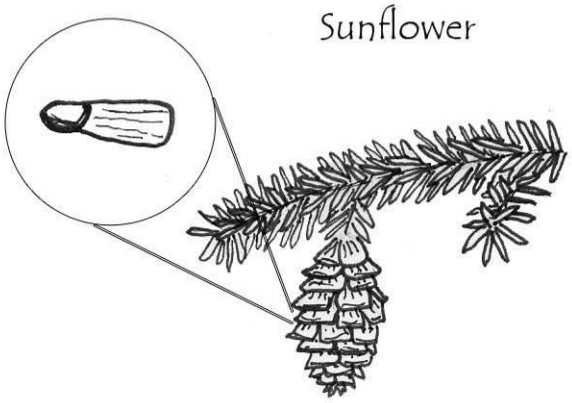
Sunflower



Peanut



Apple

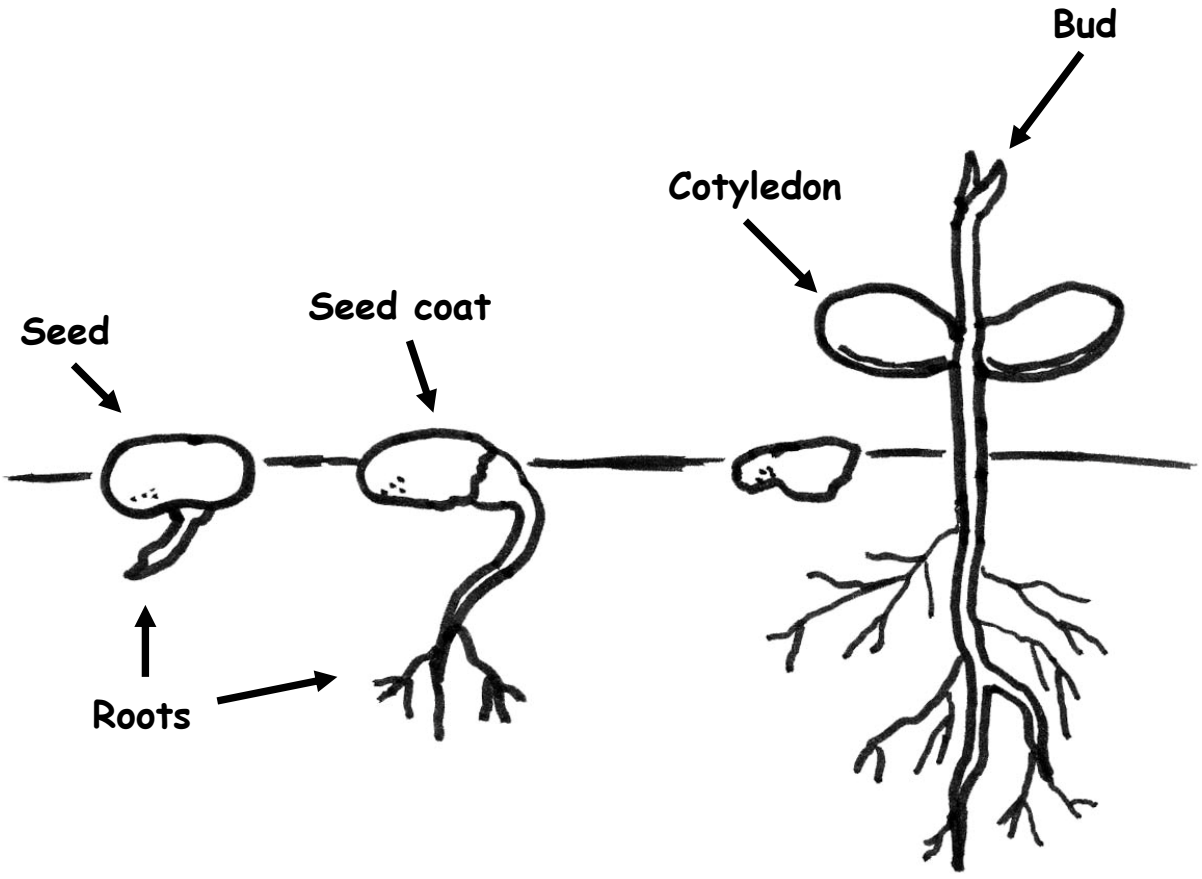


Spruce

Germination

Seeds germinate, or begin to sprout, when they have enough water and warmth.

Color the seed brown.
Color the seed coat black
Color the cotyledons green.
Color the roots yellow.
Color the bud purple.



Growth

What do plants need to grow?

They need **nutrients** and **water**, just like you! Plants need **light** and **air**, too.

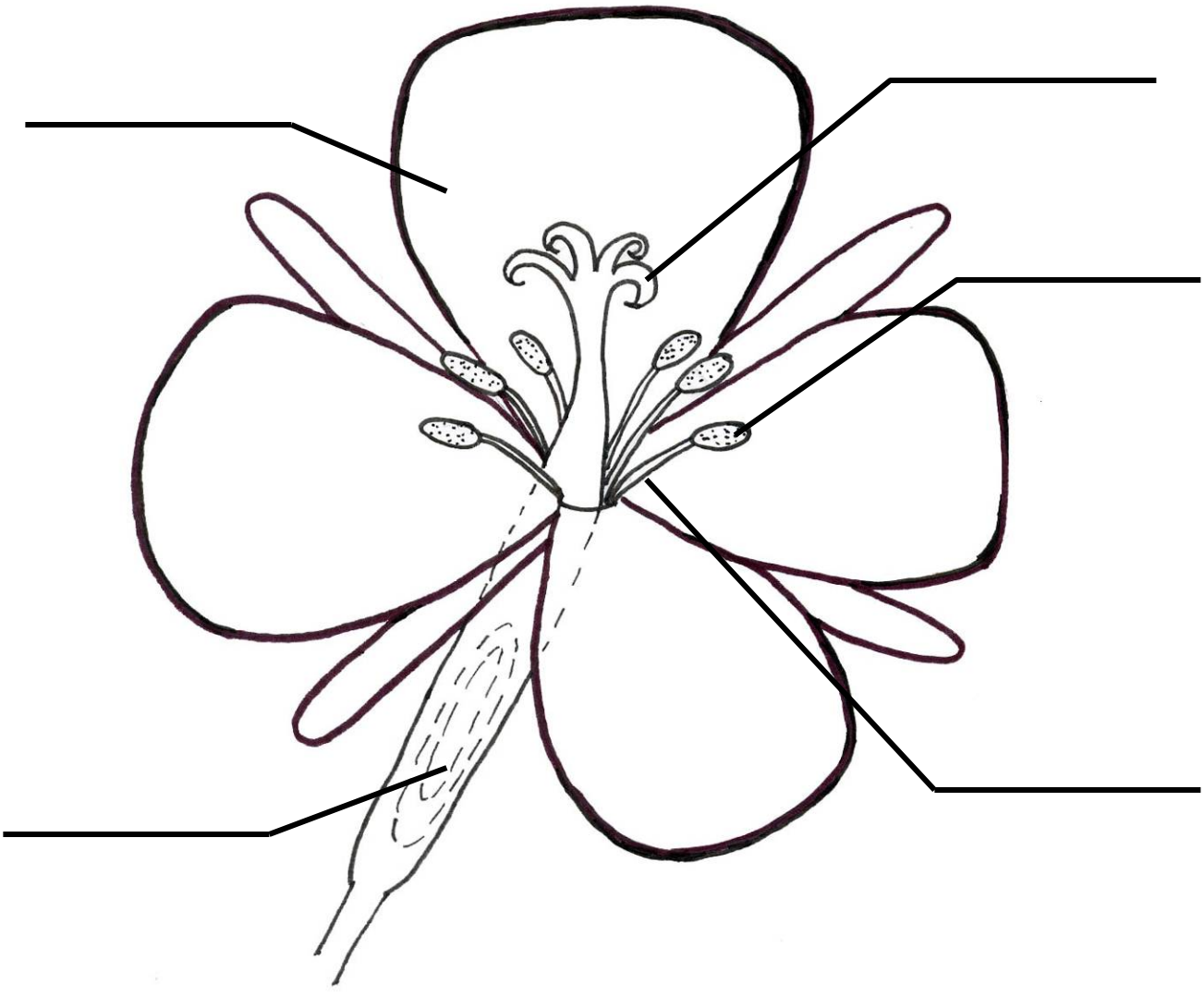
1. Roots take me from the soil up into the plant. I keep the plant healthy. What am I? _____ _____ _____	**2. I am warm and bright. I hit the leaves and plants use me to make food. What am I?** _____ _____ _____
3. You cannot see me, but I am all around. Plants get the gas they need from me. What am I? _____ _____ _____	**4. I come down as rain, and the plant drinks me up through its roots. What am I?** _____ _____ _____

Pollination and Fertilization

Flowers hold the pollen and the ovule (like an egg) for the plant. The petals attract insects to come and get their pollen which is on the stamen. Insects take the pollen to other flowers where it sticks to the pistil. This is called *pollination*. When the pollen meets the ovule inside the pistil the flower is *fertilized* and makes a seed.

Label these parts on the flower:

petal pollen stamen ovule pistil



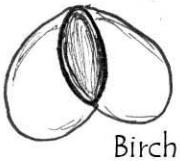
Seed Dispersal

Seeds are scattered to new places to begin the plant life cycle again. Dispersal means taken to a new place. Seeds can travel to new places by wind, animals, or water.

Seeds that move on the wind

Spruce

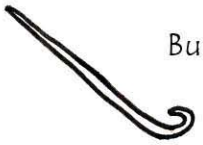
Dandelion



Birch

Seeds that move on fur, feathers, or clothing

Quackgrass



Burdock

Foxtail Barley

Seeds that move on water

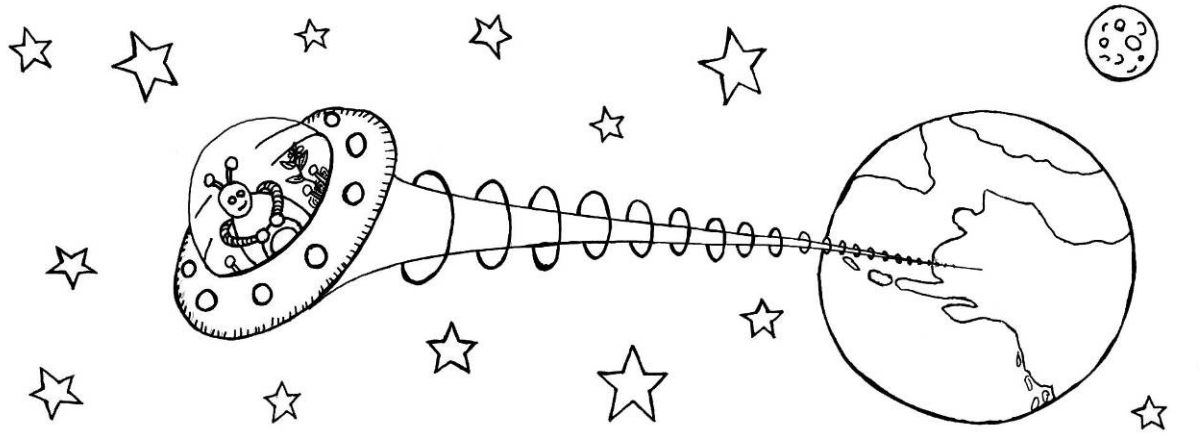
Coconut

White Sweetclover

Make a seed that flies.	Make a seed with hooks.	Make a seed that floats.

Lesson 2

Invasion in Alaska!?



Grade Level: K-6
Alaska State Science Standards: SA2.1 [3-6]
Subject: Science, Language Arts
Target Skills: communication, inference
Duration: 40-60 minutes (Two sessions for early primary students)
Setting: Classroom
Vocabulary: alien, weed, invasive plant

INSTRUCTIONAL GOAL ✦

This lesson serves as a unit pre-assessment to identify previous subject knowledge and possible misconceptions.

PERFORMANCE OBJECTIVE ✦

Students will work cooperatively to discuss what they already know and wonder about invasive plants and weeds, and how they could learn more about these plants.

MATERIALS ✦

- Chart Paper
- Markers
- LCD Projector
- "Invasion!" PowerPoint presentation on *WEED WACKERS* CD

TEACHER BACKGROUND ✦

Historically, the cold climate, large expanses of permafrost laden soil, geographic isolation, and small human population have protected Alaska from invasive plants. As climate changes and human development continues to increase, however, more types of alien plants have started appearing across the state (Carlson and Shepard 2007). Some of these weeds and invasive plants have begun to move into our natural ecosystems. One example is the pretty and seemingly harmless white sweetclover (*Melilotus officinalis*). This plant was brought to Alaska as forage for livestock and a nectar source for honey production. Currently, however, white sweetclover is beginning to take over the habitats of several rivers in Alaska and has seriously changed the plant communities.

Sweetclover's dominance on river floodplain habitats may even threaten the success of a rare type of willow that only grows in Alaska (endemic *Salix setchelliana*) (Spellman and Wurtz 2007). Even though invasive plants are starting to take root in Alaska at a faster rate than ever, we still have a unique opportunity to help prevent invasives from spreading any further. The first step in preventing invasive plants from spreading in Alaska is to increase citizen awareness of invasive plants. What better place to start than in your classroom?

This lesson serves as a unit gear-up for the study of plant invaders in Alaska, an introduction to the concept of plant invasion, and a pre-assessment of student knowledge on this topic.

ADVANCED PREPARATION ✦

This lesson employs a KWL Chart, a common teaching technique to conduct a pre-assessment of the class knowledge and potential misconceptions on invasive plants or weeds.

The chart can be made on a large sheet of butcher paper divided into three columns: **K**now, **W**onder, and **L**earn. In the K column, list what students think they already know about the topic. Record what students wonder in the W column. List ways that students think they can learn about the topic in the L column (e.g. read books, look on website, invite university scientists to school, interview farmers). The chart can remain hanging in the classroom throughout the unit. To prepare for this lesson, teachers must make a blank K-W-L chart.

PROCEDURE ✦

1. **(Gear-Up)** Dim the lights in the classroom. Tell the students a parable about aliens invading Alaska:

   "*The other night I had a dream... Aliens came right into my backyard. I was scared. I was frightened. Why were they here? I crept slowly outside to get a better look. I saw the invaders and they were the most beautiful beings I had ever seen. They were so colorful and beautiful that I couldn't help but be drawn to them. 'Do you come in peace?' I asked. 'We want water. We want light. We want space in the soil. That is all we want. We come in peace from a far off land.' The aliens were so beautiful, and seemed peaceful enough. I convinced my family to let them stay in our backyard. Summer turned to winter, and the aliens stayed all winter under the snow. Spring came and I wondered about my alien friends. Soon I saw them. They had multiplied and filled my backyard. They even had spread into my neighbor's yard. I drove down the road, there they were! They had taken over the neighborhood, and had started to take over all of Fairbanks. Was all hope lost against these alien invaders? 'What have I done?!' I screamed. Then, I woke from my dream, sweat was on my forehead. I am still a little scared from the whole thing.*"

   Ask students if they believe this story could really happen? Why or why not? Introduce invasive plants and weeds. Invasive plants are plants from another region have been introduced intentionally or unintentionally by humans and have a tendency to spread rapidly on their own. Weeds are any plant growing in a place that it isn't desired. *(Definitions of these terms will be further covered in the next lesson.)*

2. **(Explore)** Show slides of an actual alien invasion sites from the

"Invasion!" PowerPoint presentation included on the *WEED WACKERS* CD. Information on the species and location of the invasion site is located on the presentation slides.

3. **(Explore)** Have pairs of students brainstorm what they already know about invasive plants or weeds. The class mixes until the teacher calls "freeze." The students find the partner closest to them to discuss the topic. Provide thirty seconds of "think time" where no student is allowed to speak. In the next thirty seconds, student A shares what he or she already knows about weeds while student B listens. For the final thirty seconds student B shares while student A listens.

4. **(Generalize)** Gather the class back together and have ten students report on what their partner told them. Record the observations on the K-W-L chart in the K column.

5. **(Explore)** Again, using the same sharing technique, have the students brainstorm what they wonder about weeds. Have each student come up with one or more questions during the allotted time period.

6. **(Generalize)** Gather the class back together and have ten students report on what their partner told them. Record the questions on the K-W-L chart in the W column. After having students share their questions, have students quickly brainstorm ways that they could find some answers. Record some of their ideas on the K-W-L chart in the L column.

Note: For younger K-1 students, the second part of the lesson could be broken into another session depending on the attention level of the kids and /or the time of the year it is presented.

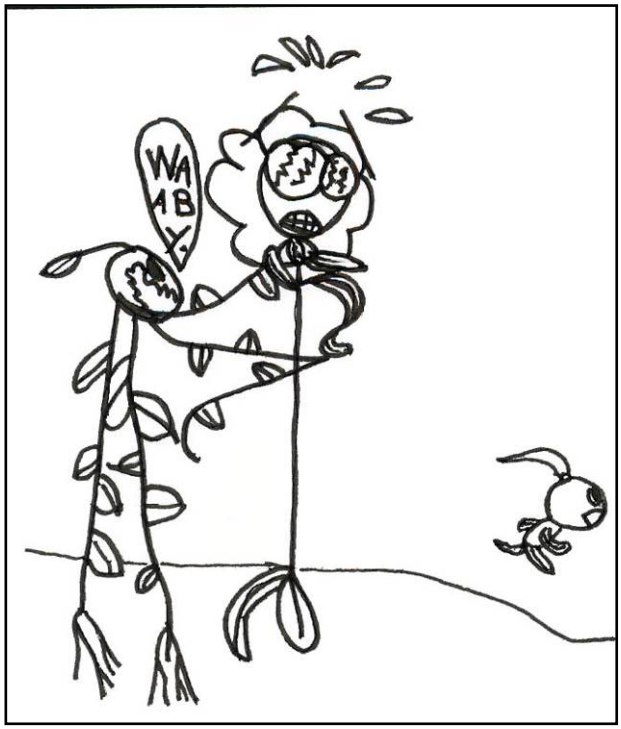


Figure 2.1 Attack of the Alien Plants! Drawing by Isaac Blue, age 7, Denali Elementary.

EVALUATION ✦

Throughout the class study of invasive plants in Alaska, continue to refer back to the K-W-L chart that the class developed during this lesson. As the students learn about invasive plants, they can refer back to this chart and confirm or correct what they had thought in the K column, answer questions they had in the W column, and check off the learning strategies in the L column that they employed during their investigations.

EXTENSIONS ✦

- Add to the W and L columns on the K-W-L chart as student questions become more informed and more complex, and knowledge of the

learning resources available on invasive plants increases.

- Read these excellent books aloud for great information on alien invaders:

  Aliens from Earth: When Animals and Plants Invade Other Ecosystems by Mary Batten (appropriate for grades 1-4)

  Plant Invaders by D.M. Souza (appropriate for grades 3-6)

REFERENCES ✦

Batten, M. 2003. *Aliens from Earth: When Animals and Plants Invade Other Ecosystems*. Peach Tree Publishers, Atlanta, Georgia.

Carlson, M. L., and M. Shephard. 2007. Is the spread of non-native plants in Alaska accelerating? In T.B. Harrington and S.H. Reichard (eds.), Meeting the Challenge: Invasive Plants in Pacific Northwestern Ecosystems, PNW-GTR-694. Portland, Oregon: USDA, Forest Service, PNW Research Station.

Souza, D.M. 2003. *Plant Invaders.* Watts Library—Scholastic Books, New York, NY.

Spellman, B.T., and T. Wurtz. 2007. Impacts of sweetclover on riparian plant communities. Proceedings of the 8th annual Alaska Committee for Noxious and Invasive Plant Management Workshop, Fairbanks, AK.

Lesson 3

Weedy Definitions

Grade Level: 1-6
Alaska State Science Standards: SC1.1[3,5], SC2.1-2.2[3-6]
Subject: Science, Language Arts
Target Skills: communication, classification
Duration: 40-60 minutes
Setting: Classroom
Vocabulary: native, non-native, alien, exotic, invasive, weed

INSTRUCTIONAL GOAL

Students will learn pertinent vocabulary for the exploration of invasive plants in Alaska.

PERFORMANCE OBJECTIVE

Students will play an interactive game to demonstrate their understanding of the meaning of "native plants," "non-native/ alien / exotic plants," "invasive plants," and "weeds."

MATERIALS

- Fly swatters
- Scissors
- Weedy Word Cards
- Weedy Question Cards

TEACHER BACKGROUND

Several terms are used when talking about invasive plant ecology and management. The goal of this lesson is to clarify and define terms that will be used throughout this unit of study. In the reference book *Invasive Plants of Alaska* (2005), the following definitions are used:

Native Plant- A plant that lives and grows naturally in a particular region.

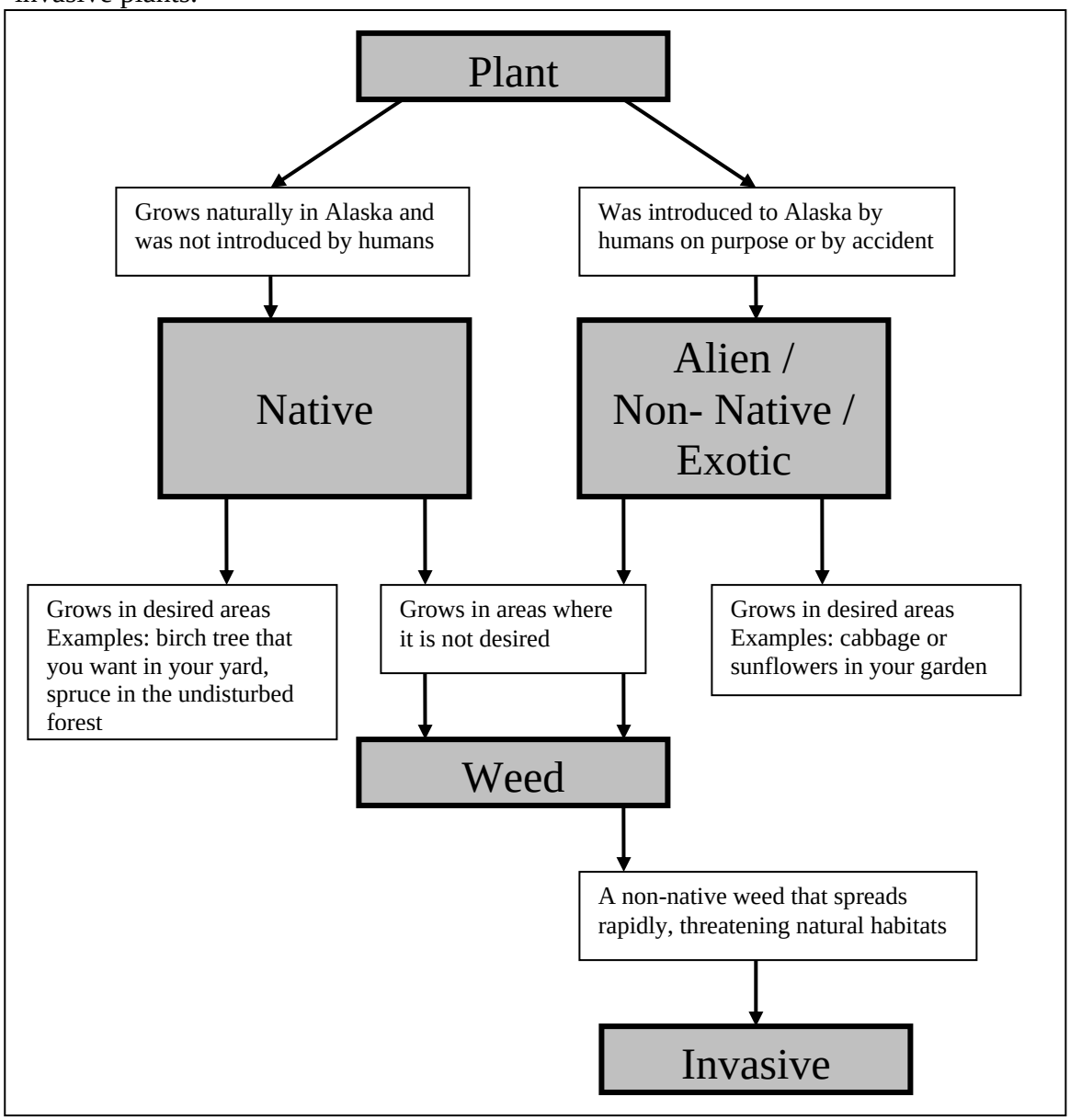
Alien, Exotic or Non-Native Plant- A plant whose presence in a given area is due to the accidental or intentional introduction by humans. Alien, exotic, and non-native are all synonyms.

Weed- A weed is any plant whose presence is undesirable to people in a particular time and place. A weed could be either native or non-native (e.g. a native willow seedling growing in your garden is a weed if you don't want it there). In common usage, however, people use "weed" to describe quickly growing, abundant non-native plants.

Invasive Plants- Non-native plants that produce large numbers of offspring and have the potential to establish and spread in natural areas. Some references define invasive species as non-native plants that have a negative effect on ecosystems or cause harm or economic losses to humans.

This educators' guide will use the same definitions

Figure 3.1 A diagram showing the relationships between important terms in the study of invasive plants.



ADVANCED PREPARATION ✦

- Make copies of Weedy Word Cards, enough for every student to have their own set.
- Make copies of Weedy Question Cards, one set for each small group of students. (Laminating a set of cards for a learning center could be an option.)

PROCEDURE ✦

1. **(Explore)** Introduce the words "native," "non-native," "alien," "exotic," "invasive," and "weed" to the class. What do you think they mean? Have students come up with definitions orally.

2. **(Generalize)** Revise and refine student definitions into accurate definitions (see definitions in "Teacher Background" above) and record them on the board. Point out the three synonyms: alien, non-native and exotic. Use a diagram to show the relationships between the words like the diagram included in figure 3.1. Emphasize the similarities and differences between the terms. Show that invasive plants are a specific type of non-native plants that are harmful to natural ecosystems. Students should be made aware of the fact that alien plants are not bad or evil in and of themselves, and that not all alien plants are harmful. Some non-native plants are quite useful to humans and do not spread on their own. Have you ever seen a cabbage growing in the untouched wilderness?

3. **(Explore)** Have students scan the room for plants growing in the classroom, plants growing outside the window, or pictures of plants on posters and books. Which do they think are native to Alaska and which do they think are alien? Are there aliens among you right now?! Are any of these plants weeds? How would you know if they were? Are any of the aliens invasive? How would you know?

4. **(Apply)** Play the weedy definitions fly swatter game in small groups.

Weedy Definitions Game

Prepare:

Students cut out their Weedy Word Cards. Each group cuts one set of Weedy Question Cards and places them in a container. Each student gets a fly swatter.

To play:
Grades 3-6
- Each student lays their set of Weedy Word Cards face-up in the middle of the group.
- Students take turns choosing a Weedy Question from the container and reading it to the group.
- All students (except the question reader) smack an answer to the question with their flyswatter. If they are correct, the student keeps the Weedy Word Card.
- Student with most Weedy Word Cards wins.

Grades K-2
- Stick Weedy Word Cards on the chalkboard.
- Students take turns in pairs to come up to the chalkboard and play the game.
- The teacher reads the questions and students smack the correct answer.

- The winner of the round challenges a new student. A round consists of being the first player to get 3 swats (answers) correct.
- Play goes on as the students go up and take turns challenging the previous winner. The teacher can end the game at any time. If motivation is high, play the game until all the students have had a turn at the board.

EVALUATION ✦

Students score themselves on the game and evaluate their own mastery of the definitions. Teacher may orally quiz students using weedy question cards to assess student understanding of these definitions.

EXTENSIONS ✦

For 5th and 6th graders, have students write their own Weedy Question Cards to play with in groups.

REFERENCES ✦

Alaska Exotic Plant Information Clearing House. 2005. *Invasive Plants of Alaska*. Alaska Association of Conservation Districts Publication, Anchorage, AK.

Weedy Word Cards

Alien	Invasive
Exotic	Native
Non-Native	Weed

Weedy Question Cards

I am a willow seedling growing in your strawberry patch.
What am I? Answer: Weed

I am a plant that originally came from Europe.
What am I? Answer: Alien, Exotic or Non-Native

I don't usually grow in Alaska, but I hitchhiked up here as a seed on a truck tire.
What am I? Answer: Alien, Exotic or Non-Native

I came up to Alaska from Oregon in some straw for sled dogs to sleep on, and now I am spreading all over the mushing trails.
What am I? Answer: Invasive

I am a spruce tree, a species that who has been growing in Alaska for thousands of years.
What am I? Answer: Native

I started out as a pretty flower patch planted in a garden, but now I'm moving into the forest. Just try to stop me!

What am I? Answer: Invasive

I was brought up to Alaska by people a long time ago, but I can't seem to move anywhere without the help of humans.

What am I? Answer: Alien, Exotic or Non-Native

I am a dandelion growing in your green grass. You don't like me there and want to pull me up.

What am I? Answer: Weed

I am growing up in the cracks in the sidewalk at your school, but the janitor is always trying to kill me so I don't make the cement crumble.

What am I? Answer: Weed

I've grown naturally in Alaska since before humans even lived here.

What am I? Answer: Native

Write your own: _____

_____

What am I? Answer: _____

Write your own: _____

_____

What am I? Answer: _____

Write your own: _____

_____

What am I? Answer: _____

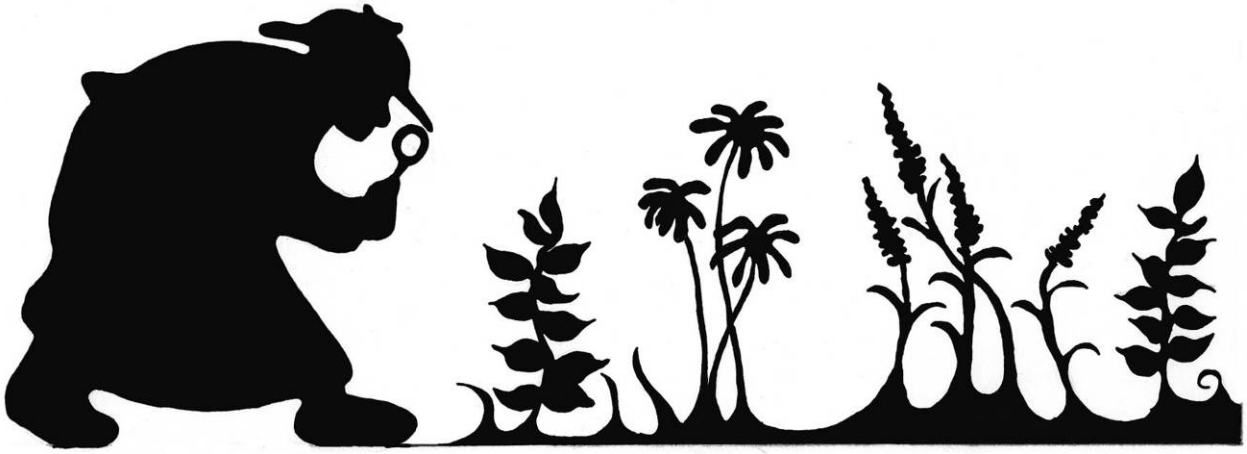
Write your own: _____

_____

What am I? Answer: _____

Lesson 4

On the Case: Investigating Alaska's Alien Invaders



Grade Level: 1-6
Alaska State Science Standards: SA1.1[3-6], SA2.1[5], SA3.1[3-6], SC1.1-1.2[3,4], SC2.1-2.2[3-6], SC3.1[3-6], SE1.1[3,5]
Subject: Science, Language Arts, Art, Technology, Social Studies
Target Skills: observation, communication, classification
Duration: 30 minute read-aloud and
60 minute activity (in 1 or 2 sessions)
Setting: Classroom
Vocabulary: species, research, specimen

INSTRUCTIONAL GOAL ✦

Students will learn about some of Alaska's most common or dangerous invasive plants through observation and guided research.

PERFORMANCE OBJECTIVES ✦

1. Students will use internet resources, books, and pamphlets to identify pressed invasive plant samples and record information that they discover about the plant.
2. Students will create a "WANTED" poster for an invasive plant species based on their research.

MATERIALS ✦

- *Nate the Great Stalks Stupidweed* by Marjorie Weinman Sharmat
- "Invasive Plant Detectives" Worksheet
- Pressed invasive plant specimen (available in the companion teaching materials kit)
- Computers with internet access

- "Bird Vetch: An Alaskan Invader" by Katie Villano (for early primary students)
- Invasive plant identification books, pamphlets, and brochures (listed on the student worksheet)

TEACHER BACKGROUND ✦

Scientists are often like detectives collecting clues so that they might shed some light on a mystery. In this lesson, students will assume the role of an invasive plant detective. They will collect clues on a mystery plant specimen, then identify it using a variety of invasive plant resource materials. They will read about their plant, and finally create a "WANTED" poster full of the information they gathered. They will crack the case and get the word out for the arrest of some of Alaska's bio-criminals.

This lesson is designed to introduce students to invasive plants that are common across the state of Alaska. The following tables briefly describe the species this lesson will cover. Table 4.1 shows some of the most dangerous invasive plants in Alaska. The pressed specimens of the more threatening species in the teaching materials kit are labeled in red with a mad face. Table 4.2 shows some of the non-native plants that are quite common, less threatening species that you are likely to find growing around your school grounds. The pressed specimens of more innocuous species in the teaching materials kit are labeled in black. Information for these tables was taken from AKEPIC (2005) and Royer and Dickinson (2004). All photographs are from AKEPIC (2005).

Table 4.1 Some of Alaska's most dangerous invasive plant species.

Photo	Flower Color	Common/ Scientific Name	Reason for Concern
	Purple	Bird Vetch (*Vicia cracca)*	Overgrows native herbs, shrubs and tree seedlings and competes for light; changes soil conditions.
	Purple	Canada Thistle (*Cirsium arvense*)	Competes for water and nutrients and displaces native vegetation; exudes chemicals to eliminate native plants; can increase fire frequency and severity.

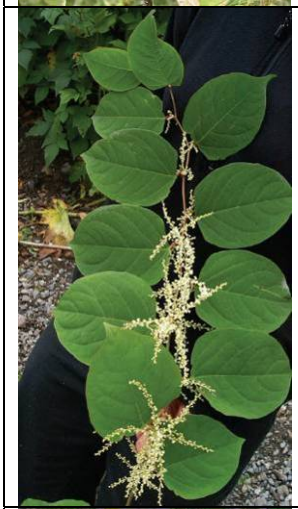
Photo	Flower Color	Common/ Scientific Name	Reason for Concern
	Purple / Pink	Purple Loosestrife (*Lythrum salicaria*)	Displaces native wetland vegetation and the wildlife dependent on wetland habitats.
	Pink	Hempnettle (*Galeopsis tetrabit*)	Reduces abundances of native herbs by consuming nutrients and water; delays native plant establishment.
	White	Japanese Knotweed (*Polygonum cuspidatum*)	Shades out native plants and reduces biodiversity; reduces germination of native seeds; clogs waterways and lowers the quality of stream habitats.
	White	Oxeye Daisy (*Leucanthemum vulgare*)	Can form dense stands, displacing native species and reducing biodiversity.

Photo	Flower Color	Common/ Scientific Name	Reason for Concern
	White / Yellow	White or Yellow Sweetclover (*Melilotus officianalis*)	Overtops and shades native plants reducing the establishment of native seedlings; alters soil conditions.
	Yellow	Narrowleaf Hawksbeard (*Crepis tectorum*)	Contaminates crops; rapidly colonizes burned areas in interior Alaska; showy flowers detract from aesthetic quality of wild lands
	Yellow	Perennial Sowthistle (*Sonchus arvense*)	Competes for soil moisture reducing native biodiversity; may slow succession of native plants.
	Yellow	Yellow Toadflax (*Linaria vulgaris*)	Suppresses native herbs by out-competing them for soil and water; changes soil; poisonous to many animals

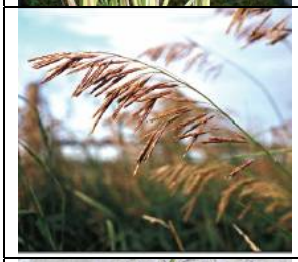
Photo	Flower Color	Common/ Scientific Name	Reason for Concern
	Orange	Orange Hawkweed (*Hieracium aurantiacum*)	Forms dense mats, eliminating all native species and reducing biodiversity; exudes chemicals to eliminate native plants.
	Green	Cheatgrass (*Bromus tectorum*)	Increases the frequency of wildfires; out-competes native plants for soil moisture; sharp spikelets hurt the eyes and mouths of animals.
	Green	Smooth Brome (*Bromus inermis* ssp. *inermis*)	Displaces native plants and reduces biodiversity; may inhibit natural succession
	Green	Quackgrass (*Elymus repens*)	Out-competes native grasses for water and nutrients; exudes chemicals that prevent the growth of neighboring native plants; can hinder the establishment of shrubs and trees during succession.

Table 4.2 Some common, less dangerous non-native plants in Alaska.

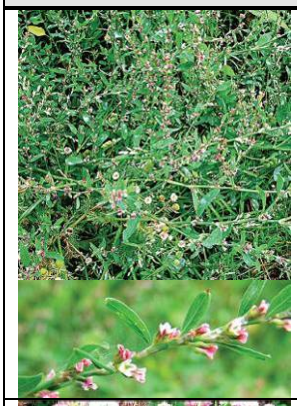
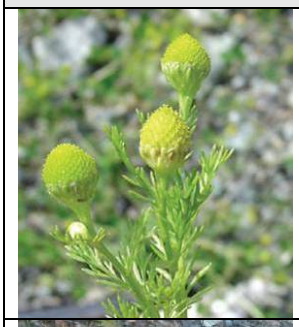
Photo	Flower Color	Common/ Scientific Name	Reason for Concern
	Pink	Prostrate Knotweed (*Polygonum aviculare*)	Reduces nutrients and moisture available for native plants; common weed in yards, gardens, and roadsides.
	White / Pink	Alsike Clover (*Trifolium hybridum*)	Reduces nutrients and moisture available for native plants; changes soil conditions.
	White	Shepherd's Purse (*Capsella bursa-pastoris*)	Reduces nutrients and moisture available for native plants, but is contained to human disturbance areas; serious weed in crops and gardens.
	White	Common Chickweed (*Stellaria media*)	Reduces nutrients and moisture available for native plants, but is largely contained to human disturbance areas; common weed in gardens.

Photo	Flower Color	Common/ Scientific Name	Reason for Concern
	Yellow	Pineappleweed (*Matricaria discoidea*)	Reduces nutrients and moisture available for native plants, but is contained to human disturbance areas.
	Yellow	Common Dandelion (*Taraxacum officinale* ssp. *officinale*)	Reduces nutrients and moisture available for native plants; one of the most common weeds in North America.
	Green	Common Peppergrass (*Lepidium densiflorum*)	Reduces nutrients and moisture available for native plants, but is contained to human disturbance areas; serious weed in agricultural crops.
	Green	Common Plantain (*Plantago major*)	Reduces nutrients and moisture available for native plants, but is largely contained to human disturbance areas; common weed in gardens and crops.
	Green	Lambsquarters (*Chenopodium album*)	Competes with native plants for water and light; spreads from human disturbance areas into natural disturbance areas.

ADVANCED PREPARATION ✦

- Assemble resource books and pamphlets on invasive plants of Alaska.
- Make copies of the "Invasive Plant Detectives" worksheet, enough for each student to have one copy.
- For early primary students, pre-load the following websites on the computers around the classroom:
  http://www.uaf.edu/ces/cnipm/plants.html
  http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm
  http://plants.usda.gov/
- For early primary classrooms, make copies of mini-book "Bird Vetch: An Alaskan Invader" by Katie Villano.

PROCEDURE ✦

1. **(Gear-Up)** Read *Nate the Great Stalks Stupidweed* by Marjorie Weinman Sharmat aloud to the class. This reading takes approximately 30 minutes to complete. It is a great reading to do during lunch periods two days in a row. Before beginning the story, explain that this story is a mystery that revolves around a missing weed. Not just any weed, a non-native weed. A weed we have right here in Alaska. While they are listening, have them pay attention to any clues that the story gives on what that weed might be.

2. **(Generalize)** After finishing the story, review the clues that Nate the Great used to crack the case. Were there any clues about the true identity of the weed?

Clue #1: "It has a yellow bud" (page 15). Yes, and a yellow flower, too!

Clue #2: "Rosamond said it will grow into a flower that will reach as high as the sky" (page 17).The flower part is true. Rosamond lied about the height.

Clue #3: The name "Superweed" is a great name for this plant. This plant grows all over the world! It is one of the most common weeds in North America. In fact, every student has probably picked one of these weeds. The weed probably even grows in your school's playground!

Can you guess what the weed is? A Dandelion! Turn to page 4 in the "Extra Fun Activities" section at the end of *Nate the Great Stalks Stupidweed*. Read the information about dandelions. Alaskan students, too, can become great invasive plant detectives by gathering clues and reading about invasive plants. You may want to do a quick review of the dandelion's life cycle (Refer back to Lesson 1, Introduction to Plants).

3. **(Explore)** Pairs of students choose a pressed non-native plant specimen from the kit. Just as Nate the Great gathered clues to solve his case, the students must gather clues about their plant and record them to solve their case. What color flowers does it have? Are the flowers large or small? Is the stem spindly and twisting or thick and straight? What shape are the leaves: thin, pointy, round, lobed, one part or many parts? What do the seeds look like? Have students record their clues on the "Invasive Plant Detectives" worksheet. Once they have gathered clues, have students identify their plants using the invasive plant identification books, pamphlets, and websites.

4. **(Generalize)** Students read about their invasive plants and record what they learned on the worksheet. Have students draw a scientific picture of their invasive plant species in the space provided.

***Adapt Lesson for Primary Classrooms:** Rather than investigating several species, focus on a single species abundant near your school or in a fieldtrip location. On the research worksheet, gather clues as a class and record them together. Have students try to find pictures of their one plant like a scavenger hunt in as many of the invasive plant resources as they can. Have students check off the pictures of the resources they found the plant in on their "Invasive Plant Detectives" activity sheet. Create a class book on your class' focal species. Or use bird vetch (*Vicia cracca*) as a focal species and use the mini-book provided with this lesson. Read the mini book aloud to the class, encouraging them to read along the larger text on the illustration page. Have students answer the questions on the third page of the "Invasive Plant Detectives" worksheet based on the mini-book reading.

How to create a class book on your class' focal species:

- Brainstorms facts that the class has learned about the focal invasive plant. Depending on the grade level, make either a language experience chart or a word box to record the shared ideas. Brainstorming can be done in pairs and then reported back to the class. Also make a list together of things the invasive plant cannot do.

- Give each student a story frame page in which they complete four sentences with an idea. Student will write three sentences with facts about the plant and one "disclaimer" sentence that is not true. Here is an example using bird vetch:

  Bird vetch can grow fast.
  Bird vetch can make lots of seeds.
  Bird vetch can tangle around other plants.
  But bird vetch cannot fish for salmon!

- Students illustrate their page for publication and do an author sharing.

- Bind pages together to make a class book.

Option for primary: This lesson could be broken into three stations where small groups rotate every 20-30 minutes. At station 1, students use the internet and other resources to research their invasive plant. At station 2, students read and discuss the mini-book *Bird Vetch: an Alaskan Invader*. At station 3, students complete their page for the class pattern book about an invasive plant. You would need adult help to man each station for the activities to be successful.

EVALUATION ✦

(Apply) Each student will create a "wanted" poster for the invasive plant the researched. Each poster should include:

- a drawing or photo of the plant,
- characteristics or clues used to identify the plant (flower color, shape, etc.),
- region of origin,
- the crimes it is charged with (shading out other plants, strangling other plants, stealing nutrients and water, etc.),
- the ecological reward for the plant's capture (more beautiful

forest, increased biodiversity, better habitat for wildlife, etc.).

Students should share their posters with the class. Hang posters in the hallway of the school as an informational bulletin board on invasive plants of your area.

EXTENSIONS ✦

- It is important for people in the community to learn about these invasive species, especially the more threatening species listed in table 1. Most Alaskans don't even know we have an invasive plant problem in the state. Brainstorm places around your town or village to hang your posters. Have students hang their posters around town with their families.
- Have students record sightings of their focus invasive plant species. Find a map of your town and record sightings using push pins. Which plants have the greatest number of sightings? Which type of non-native plants occur most often in your town, dangerous invasive plants or the common, not-so-dangerous type?

REFERENCES ✦

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Alaska Natural Heritage Program. 2008. Alaska Weed Ranking Page. Available: http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm

Royer, F., and R. Dickinson. 2004. *Weeds of Northern U.S. and Canada*. University of Alberta Press, Edmonton, Canada.

Sharmat, M.J. 1986. *Nate the Great Stalks Stupidweed*. Yearling Press, New York, NY. Reprinted in 2005 with added "Extra Fun Activities" by Emily Costello.

US Department of Agriculture (USDA) USDA Plants Database. Available: http://plants.usda.gov/

US Department of Agriculture (USDA) Forest Service. 2007. Selected Invasive Plants of Alaska. Anchorage, Alaska.

University of Alaska Fairbanks Cooperative Extension Service. "Weeds: A Roadside Field Guide to Invasive and Problem Weeds for Alaska," UAF Cooperative Extension document FGV-00140. Fairbanks, AK.

Invasive Plant Detectives

Detective Name _____

1. Take the case! Choose an invasive plant sample.

2. Gather clues to help you identify the plant. Example Clues:

   My plant has white flowers.
   My plant has seed pods that are shaped like a triangle.

Clue #1 _____

Clue #2 _____

Clue #3 _____

Clue #4 _____

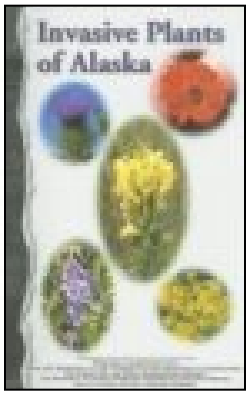
Clue #5 _____

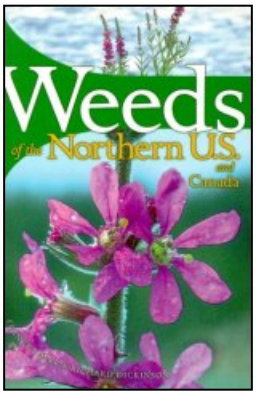
3. Identify your plant using the invasive plant books, pamphlets and websites.

My plant is called _____ .

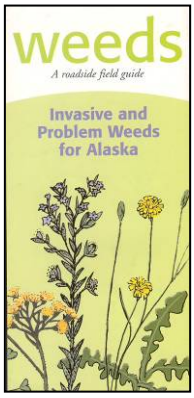
4. Read about your invasive plant in at least three different sources. Put a check mark on the sources you used.

Books:





Pamphlets:



Websites:

http://www.uaf.edu/ces/cnipm/plants.html

CNIPM
Alaska Committee for Noxious and Invasive Plants Management
College of Rural Alaska » Cooperative Extension Service
COOPERATIVE EXTENSION SERVICE

http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm

Weed Ranking Project
Alaska Natural Heritage Program
major funding from
US Forest Service, State
UAA Alaska Natural Heritage Program

http://plants.usda.gov/

USDA United States Department of Agriculture
Natural Resources Conservation Service
NRCS
PLANTS Database

5. What did you learn?

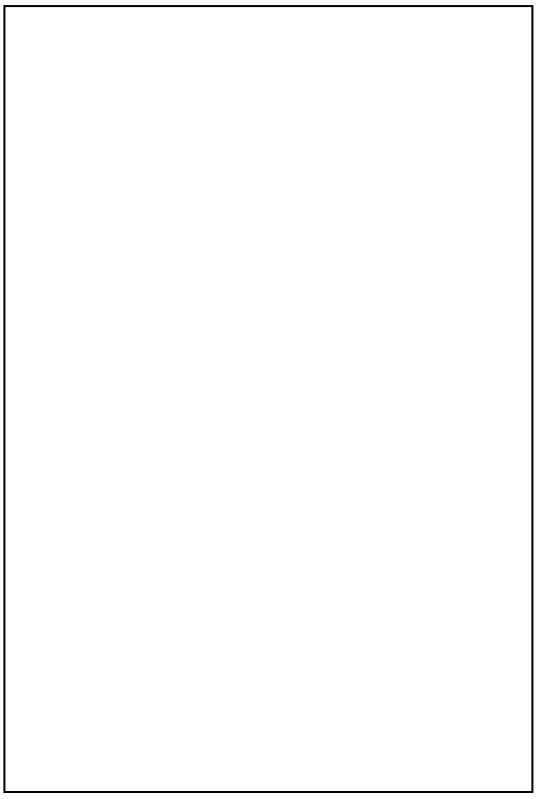
Does your plant have any special features that make it a good invader?

_____

_____

Where did your invasive plant come from originally?

_____



Draw your invasive plant here.

Name 3 things that your invasive plant can do to other plants or the habitat, and one thing it can't do.

My invasive plant can _____ .

My invasive plant can _____ .

My invasive plant can _____ .

But my invasive plant can't _____ .

Alaska Invasive Plant Mini-Book

To reproduce this mini-book, copy double sided, staple in the center, and fold in half.

BIRD VETCH

An Alaskan Invader

Name _____

Bird Vetch: An Alaskan Invader

Written and illustrated by Katie Villano
Institute of Arctic Biology
University of Alaska Fairbanks

Photos from other sources are indicated next to the picture.
Cover Illustration: *Vicia cracca,* USDA Plants Database 2008

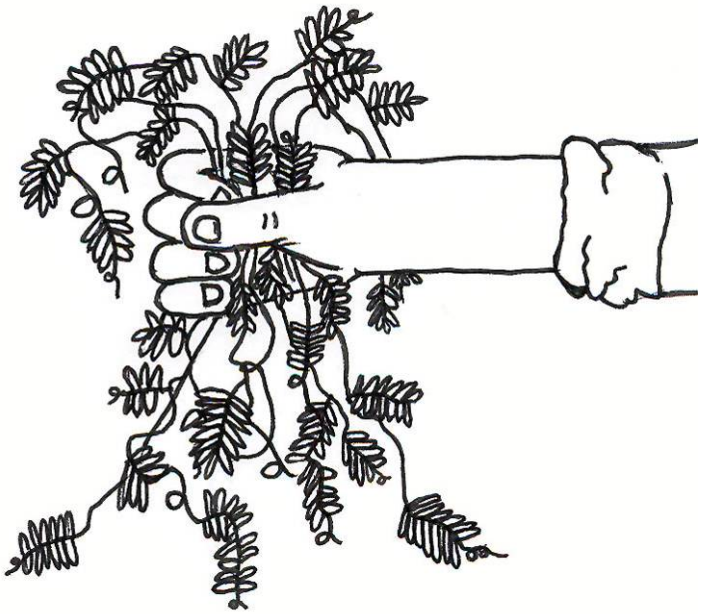
Mini-book from:
Villano, K.L., and Villano, C.P. (2008) *WEED WACKERS! K-6 Educators Guide to Invasive Plants of Alaska.* Independent publication in cooperation with the Alaska Committee for Noxious and Invasive Plant Management. Fairbanks, Alaska.

BIRD VETCH

An Alaskan Invader

Did you know there are aliens in our backyard? That's right, alien plants are invading Alaska.

We can pull vetch!



We can protect Alaska from this alien invader.

Whenever we see it, we can pull up Bird Vetch and throw it in a plastic trash bag. We can tell our families about Bird Vetch and ask them to pull it up. If there is too much vetch to pull, we can call experts to help us get rid of vetch. We can help stop this invasive alien plant!

Alien invaders live in Alaska!

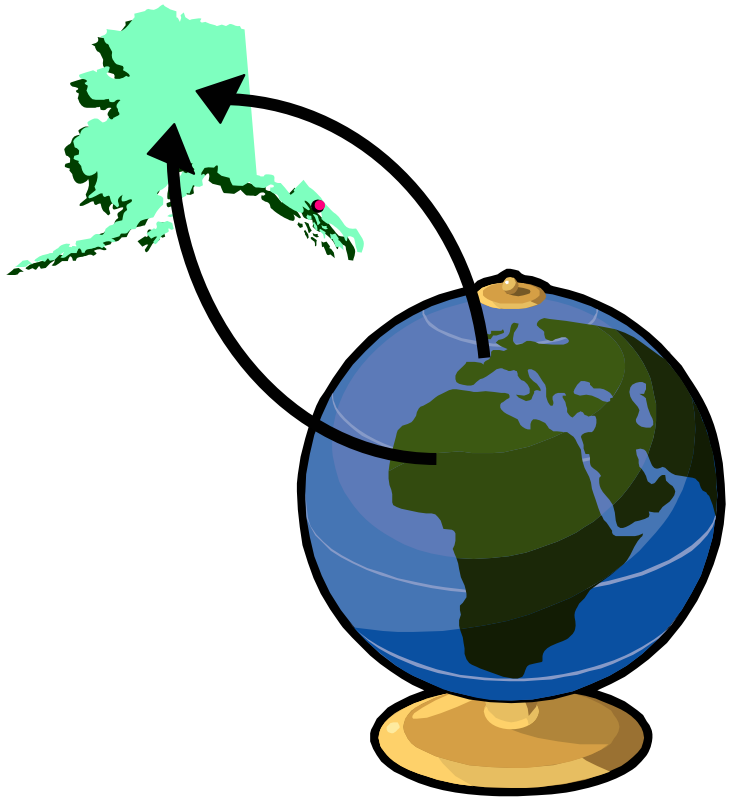
Alien plants don’t come from outer space. They come from other continents.

Alien plants were brought to Alaska by humans, either by accident or on purpose.

Most alien plants are good, like the vegetables in your garden. Some can escape and invade Alaska’s habitats.

How can we stop Bird Vetch?

We can help protect Alaska from Bird Vetch. How can we stop it from spreading into Alaska's forests and other habitats?



Alien plants came to Alaska from far away places.

Invasive alien plants spread very quickly.

Invasive alien plants can produce many seeds. These seeds sprout and grow rapidly into plants that make more seeds of their own. The seeds quickly spread into new places. Invasive aliens are plants on the move!

Vetch can hurt other plants.

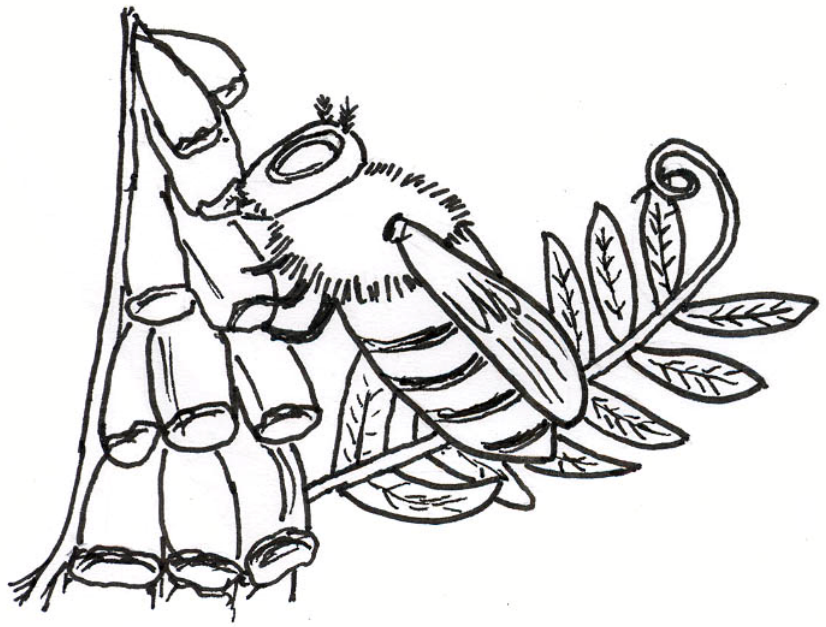
Bird Vetch can cause other plants to get hurt or die. When vetch climbs up spruce trees, it can cause the needles to fall off and the branches to die.

Image from http://api.ning.com/files/Kudzu.jpg

Invasive alien plants spread quickly.

Invasive alien plants can harm other plants and change habitats.

Invasive alien plants can out-compete some of Alaska's plants for many of the things plants need: water, light, soil nutrients, and space. They can change a habitat's soil, the types of plants that live there, and even the types of animals.



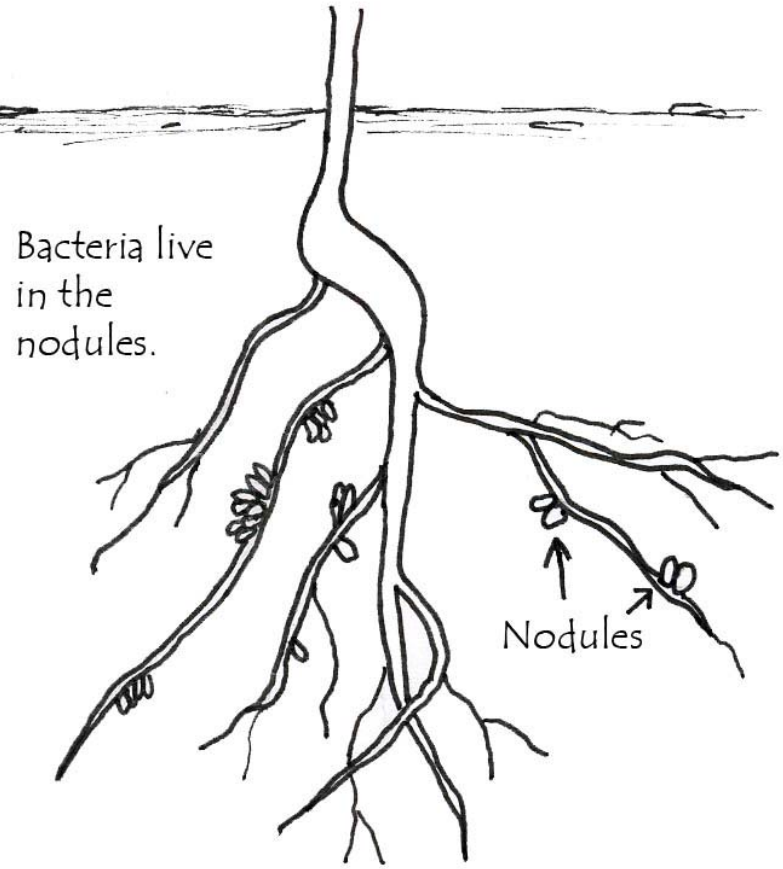
Vetch can steal insect pollinators.

Bird Vetch can grow in large patches, with many flowers. Vetch flowers can steal bees and other pollinators from Alaska's native flowers. If vetch gets pollinated more than native plants, then it will also have more seeds than native plants.

Image from http://www.ext.vt.edu/pubs/envirohort/426-080/image2.jpg

Invasive alien plants can harm other plants.

Bird Vetch is an invasive alien plant in our own back yard. It is taking over the roadsides and open fields. Vetch is even starting to spread into the forests.

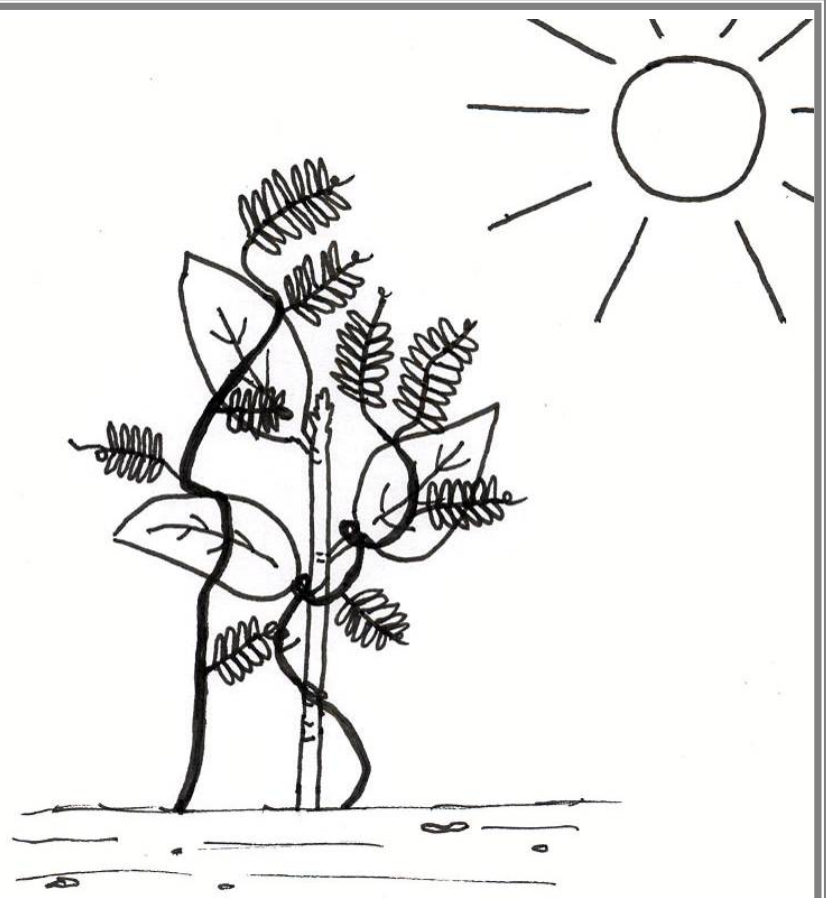


Vetch can change the soil.

Bird Vetch can change the habitat by changing the soil. Vetch has a relationship with underground bacteria that lets them put nitrogen into the soil. Nitrogen is a nutrient that vetch uses to help itself grow quickly.

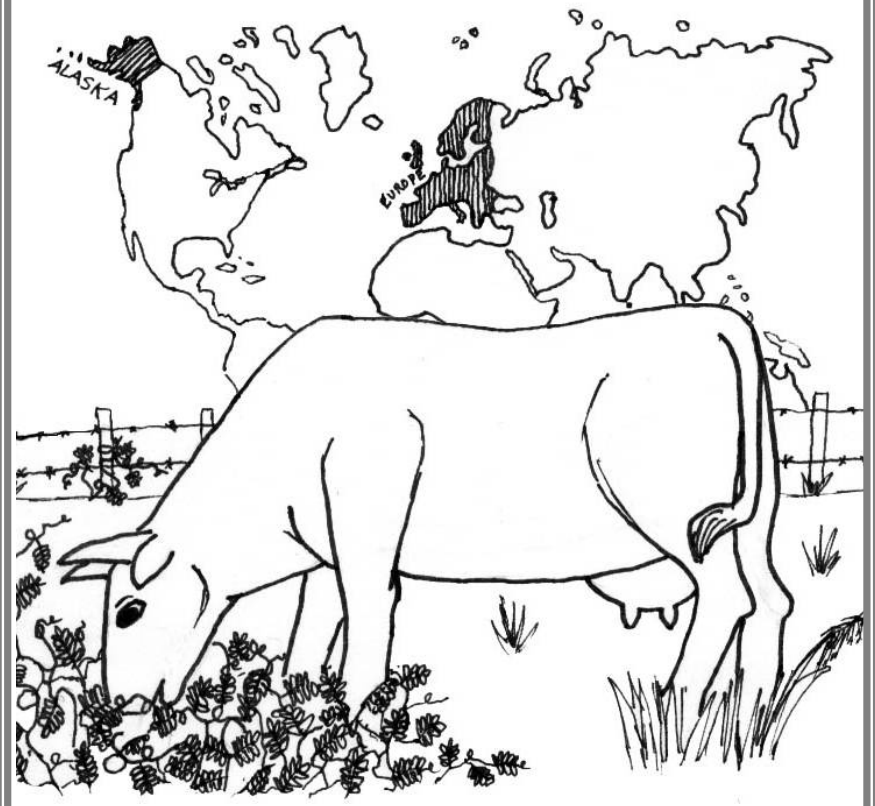
Bird Vetch is invading Alaska!

Bird Vetch was brought to Alaska in 1909 by scientists who thought it could make good food for farm animals. It was originally from Europe.



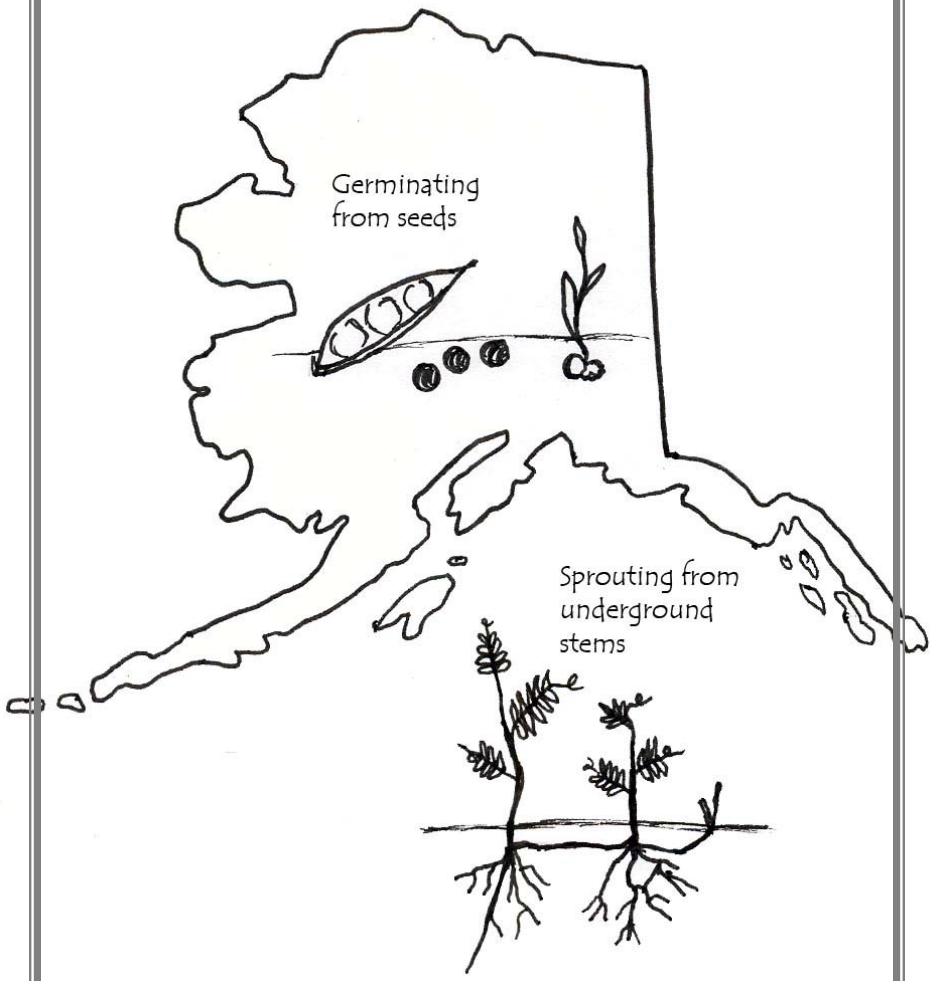
Vetch can climb over plants to steal light.

Bird Vetch can steal light from other plants by climbing over them with their curly tendrils. They can grow as tall as an adult human.



Bird Vetch came from Europe.

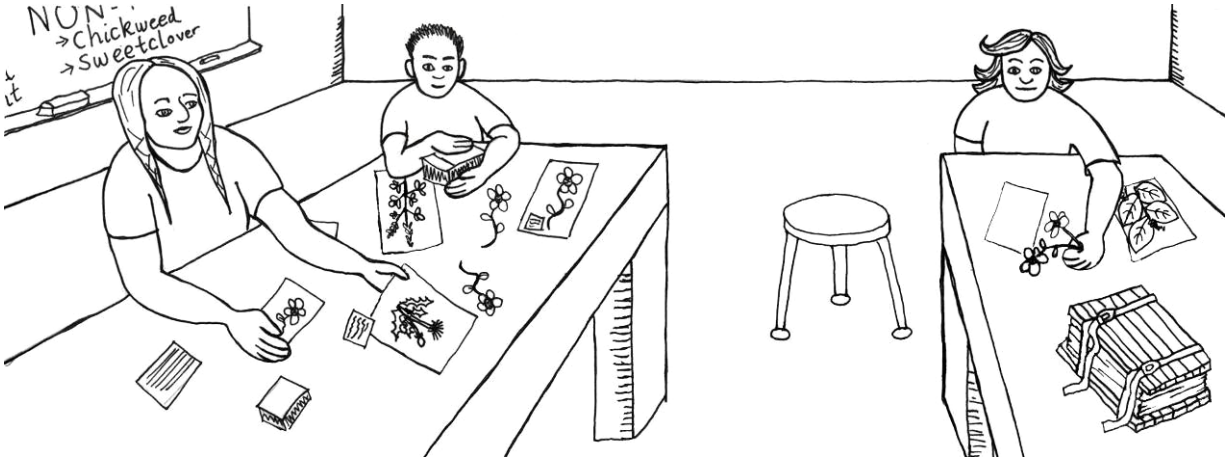
After it was planted, vetch got loose from the fields. It spread quickly throughout Alaska. It can spread by seed, by underground stems, and by tangling onto trucks and equipment.



Vetch has spread in Alaska.

Lesson 5

Native or Non-Native?



Grade Level: 1-6
Alaska State Science Standards: SA2.1[3-6], SC1.1[3-5], SC1.2[3,6], SC2.1-2.2[3-6], SE2.1[3-6]
Subject: Science
Target Skills: classification, identification, communication
Duration: two 40 minute sessions
Setting: Outside and classroom
Vocabulary: herbarium, specimen, plant families

INSTRUCTIONAL GOAL ✦

Students will learn to distinguish between native and non-native plant species of Alaska.

PERFORMANCE OBJECTIVES ✦

1. Students will collect and press plants from a local area.

2. Students will classify pressed plant specimen into native and non-native categories.

3. Students will identify non-native plant species among a diversity of species in a relay race.

MATERIALS ✦

- Fresh plant specimen (if teaching lesson in June-early September)
- Prepared pressed plant specimen (if teaching lesson in late September-May)
- Plant press (or heavy books, cardboard, and newspaper)
- Index cards (cut in half)
- Acid-free cardstock paper
- Contact paper
- Plant identification books
- Sticky notes
- Plastic grocery bags or gallon-size freezer bags

TEACHER BACKGROUND ✦

Preventing the spread of invasive plants in Alaska is certainly a "pressing" matter. In this lesson, students will learn to collect and press plants, and will use their pressed plant specimen to learn the difference between native and non-native species in their area. A **specimen** is simply an individual plant that is taken to represent other plants of the same species.

Why press and preserve plant specimen? Preserved plants can allow scientists to study how a single species varies in different areas or how it changes through time. Beyond a single species, a plant collection can reveal a snapshot in time of all the species of plants that inhabited an area. They can also record the introduction of new species. In 2007, Dr. Matt Carlson, from the University of Alaska Anchorage and Micheal Shephard, from the United States Forest Service, were able to use past and present plant collections from throughout Alaska to see how quickly non-native plants are spreading in the state. They found that of all the plants collected for herbariums in Alaska, the proportion of plants that were non-native or invasive had tripled between the year 1941 and 2006 (Carlson and Shephard 2007). An **herbarium** is a special place were plant collections are held that allows the plants to stay preserved in dry, pest-free cabinets.

The ability to correctly identify plants is a key skill in the fight against invasive plants. We don't want to go around pulling up the native plants in Alaska's habitats! In this lesson, students will learn to distinguish the non-native plants from related or similar looking Alaskan native species. It is easy to confuse plants based on the color of the flowers or the shape of the plant. For example, the invasive plant purple loosestrife looks very similar to our native fireweed (Figure 5.1). Both plants have light purple or dark pink petals and have flowers that are arranged in a tall spike. When you take a closer look, you see that even though the plants look similar, they are not even in the same family. **Plant families** are groupings of plants based largely on a plant's flowers or reproductive structures. Purple loosestrife is in the Loosestrife Family (Lythraceae) which have 3-16 sepals, 3-16 petals, 6-32 stamens, and a single style. Fireweed, on the other hand, is in the Evening Primrose Family (Onagraceae) which have flower parts (sepals, petals, stamen, and pistils)

Figure 5.1 Native fireweed and non-native purple loosestrife could easily be confused with each other. Be careful!

Photo by Katie Villano

Fireweed
(Native to Alaska)
Evening Primrose Family

Photo by John Randall, the Nature Conservancy

Purple Loosestrife
(Non-Native)
Loosestrife Family

that always occur in multiples of 2 or 4. Take a look. Fireweed has four petals, purple loosestrife has six petals. In Alaska, there are many families of plants that have both native and non-native species occurring. When trying to tell a native plant from a non-native plant within the same family you must look very carefully at the flowers, leaves, and stem. Some of the major families with both native and non-native species in Alaska are the Aster Family (Asteraceae), the Grass Family (Poaceae), and the Pea Family (Fabaceae). Here are some common native and non-native plant species in these families that grow in Alaska.

The Aster Family- The flowers of this family are in a tight cluster, often mistaken for a single flower. Imagine a sunflower or a dandelion. Each seed of the sunflower and the dandelion was produced by an individual flower.

Native members:
- Yarrow (*Achillea millefolium*)
- Goldenrod (*Solidago* sp.)
- Siberian Aster (*Aster sibiricus*)

Non-Native members:
- Dandelion (*Taraxacum officianale* ssp. *officianale*)
- Pineappleweed (*Matricaria discoidea*)
- Oxeye Daisy (*Leucanthemum vulgare*)
- Narrowleaf Hawksbeard (*Crepis tectorum*)
- Canada Thistle (*Cirsium arvense*)
- Perrenial Sowthistle (*Sonchus arvensis*)

The Grass Family- Unlike the aster and pea families, grasses are monocots. They are often overlooked because they do not have as showy a flower as other types of herbaceous plants. The flowers of grasses occur in a cluster at the top of the stem. Each grain or seed produced by a member of the grass family grass is the product of one of their flowers.

Native members:
- Northern Bluejoint (*Calamagrostis canadensis*)
- Beckman's Grass (*Beckmannia syzigachne*)
- Slender Wheat Grass (*Agropyron trachycaulum*)

Non-Native members:
- Cheatgrass (*Bromus tectorum*)
- Smooth Brome (*Bromus inermis* ssp. *inermis*)
- Quackgrass (*Elymus repens*)

The Pea Family- The plants in this family all have similar seed pods called legumes that look like a pea pods. The flowers of plants in the pea family also always have 5 petals: one large petal at the top referred to as a banner petal, two side petals referred to as wings, and two smaller lower petals that are fused together to form a keel.

Native members:
- Northern Hedysarum (*Hedysarum mackenzii*)
- Arctic Lupine (*Lupinus arcticus*)
- Beach Vetchling
- Alpine Milk-Vetch (*Astragalus alpinus*)
- Locoweed (*Oxytropis* sp.)

Non-Native members:
- Alsike Clover (*Trifolium hybridum*)
- White or Yellow Sweetclover (*Melilotus officinalis*)
- Bird Vetch (*Vicia cracca*)

Plant guides are very helpful in determining whether a plant is native or non-native. Often plant guides that include both native and non-native plants, will refer to non-native plants as "introduced" plants. Read carefully!

Need help identifying plants? Contact one of the invasive plant experts included in the list at the end of this manual.

ADVANCED PREPARATION ✦

- Assemble materials.
- Obtain permission to collect plants from the owner of the land you will be collecting from.
- Cut index cards in half. Pre-cut 8.5"x11" pieces of contact paper.

PROCEDURE ✦

1. **(Gear-Up)** Take plastic bags or large ziplocks and go hunt for plants. Each group of students should look for as many different species as they can find.

   Some rules for collecting plants:

   - Pick all the known invasive plants that you want. These plants were outlined and researched by students in an earlier lesson. However, if the plant is a native plant, or you are unsure, only pick it if there are 10 or more individuals of the same species in sight. Try to leave enough of the plant for it to survive.
   - Only pick one individual of a plant species as a specimen. (Unless, of course, it is a known invasive species!)
   - Endangered and threatened plants are extremely rare and should be photographed rather than collected. A list of rare plants in Alaska can be found in the *Alaska Rare Plants Field Guide* by Lipkin and Murray (1997) available at http://aknhp.uaa.alaska.edu/rareguide/Botany_Alaska_Rare_Plant_Field_Guide.htm
   - The best specimens have all the plant parts included. Try to take a specimen with a flower, leaves, full stem, roots, and seeds. Remember that this all has to fit on one piece of paper, so don't go digging up any trees!

2. **(Generalize)** Back in the classroom, students will identify their specimens using plant identification books. They will also determine if the plant is native or non-native to Alaska. On an index card, students will record the common name of the species, the scientific name, the family the plant belongs to, the date, the location that the plant was collected, and the name of the person who collected the specimen. In the bottom corner of the index card write "Native" or "Non-Native" depending on the status of the plant.

3. **(Gear Up)** Press your plants. Use the plant press included in the *WEED WACKERS* teaching materials kit to press your plant specimen. If your plants are longer than a sheet of paper, fold it into the shape of a "V," "N," or "W."

How to press a plant:

i. Open the plant press and lay a layer cardboard and blotter paper on the wooden frame. Lay down a few sheets of newsprint paper.
ii. Arrange plant on the paper so that most of the plant parts don't overlap. Try to arrange leaves and flowers so that they will be flattened straight. Place the index card with all the identification

information into the press with the plant.

iii. Place another few sheets of newsprint on top of your plant, then add another layer of blotter paper and cardboard.

iv. Continue to layer cardboard, paper, and plant specimens until all your samples are in the stack. Top the stack with cardboard and the other wooden frame. Pull the buckle strap around the two ends of the stack and pull the strap as tight as you can.

v. Wait. Your sample will be dry in a few days to a few weeks, depending on the original moisture content of the plant. For plants with a higher moisture content, or in moist climates, you may have to change out the paper in the plant press.

Alternative: You can also build your own plant press using the backs of old clipboards, plywood, or pegboard as the frame. Use layers of cardboard and newspaper, and tie the frame closed with string or large elastic bands. While a plant press provides the best results, you can even preserve plants simply by placing your specimens in newspaper or an old telephone book under a heavy pile of books.

4. **(Explore)** Have students seal their dried plants in contact paper. This will allow students to manipulate the specimen easily and use them in further activities. Take a piece of acid free cardstock paper and arrange the pressed plant on the paper. Place the half index card on the bottom right hand corner of the paper. Peal the paper backing off of the 8.5" x 11" piece of contact paper. Starting at the top of the paper, gently lay contact paper in line with the edge of the cardstock paper. Seal the contact paper into the plant specimen and cardstock paper slowly. This will help prevent bubbles from forming.

If you are teaching this lesson in the winter, prepared native and non-native plant specimens are available in the *WEED WACKERS* teaching materials kit. Native plants are labeled in green. Highly aggressive native plants are labeled in red and less aggressive non-native plants are labeled in black.

5. **(Generalize)** Using their preserved specimen, have students sort the plants into native and non-native categories. What are the similarities and differences among the non-native plants? What are the similarities and differences among the native plants? Are there any non-native plants that look similar to the native plants? What makes them look similar? Sort the plant specimens by family. Can you see any patterns within the specimen of a single family? How do they look alike? Are there any families that had both native and non-native species present? How can you tell the native plants from the non-native ones?

***Adapting this lesson for primary classrooms:**

Choose a single focal invasive plant to hunt for and press. The hunt could also be expanded to include one plant that is not their focal plant. Adult assistance will be necessary for plant identification, careful pulling and pressing, and contact paper application.

EVALUATION ✦

(Apply) The students will practice identifying non-native species by sight in a relay race game.

Native or Not Relay Race

How to play:

- Place a small sticky note over the "Native" or "Non-Native" label on the plant specimen. If you are using prepared specimen from the *WEED WACKERS* materials kit, place the specimen plant-side up, so the label on the back remains hidden.
- Divide the class into three or four teams.
- On a table on the opposite side of the classroom, lay out all the prepared plant specimen.
- Students will take turns racing to the other side of the classroom and "pulling" a *non-native* species to bring back to the team. The team can decide if they agree with the selection. If they agree, they keep the plant and send the next member of the team. If a team does not think the plant is a non-native, they send the member back to the table to put it back. This team member does not get a second chance at choosing a plant, and the turn switches to the next team member.
- Play ends when all team members have had a chance to select a plant.
- To score, teams remove the sticky notes and count how many non-native plants they collected. If the teams collected any native plants they subtract the number of native plants from their score. The team with the highest score wins.

To play in early primary classrooms:

- Play relay game similar to above, but have the students identify samples of their focal plant among samples of non-native and native pressed plants. Ask how they were able to identify the focal plant. What is special about the stem, the leaves, the flower, or the roots?

EXTENSIONS ✦

- Make pressed plant art. Paste pressed plants on blank notecards, or arrange pressed leaves and flowers inside a picture frame. The back of the notecard or artistic arrangement could list the names of the plants and whether the plant is native, non-native, or invasive.

- Collect and press plants from different types of habitats. Compare the numbers of non-native and native plant species in each place. Were there more non-native species present in the schoolyard or in the nearby woods? Make a bar graph comparing the number on non-native and native species between habitats.

- Visit an Alaskan herbarium. The University of Alaska Fairbanks Museum of the North Herbarium is welcoming to teachers and classes. You can also explore the plant collection at this museum virtually at http://arctos.database.museum/TaxonomySearch.cfm. In Anchorage, visit the University of Alaska Anchorage Herbarium.

REFERENCES ✦

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Lesson 6

Invader Weapons: Roots, Leaves, Flowers and Seeds

Grade Level: 1-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA2.1[3-4], SA3.1[3-6] SC1.1[3-6], SC1.2[3,6], SC2.1-2.2[3-6], SC3.1[3-6]
Subject: Science, Art
Target Skills: observation, communication, classification
Duration: 40 minutes
Setting: classroom
Vocabulary: adaptation, rhizome, stolon, allelopathy

INSTRUCTIONAL GOAL ✦

Students will recognize that invasive plants have adaptations that give them competitive advantages over native plant species.

PERFORMANCE OBJECTIVES ✦

1. Students will cooperatively observe and describe the plant parts of invasive plants to understand advantages invasive plants have over native plants.
2. Students will create an imaginary "Superweed" to demonstrate their understanding of invasive plant adaptations.

MATERIALS ✦

- Prepared pressed invasive plant specimen
- Hand Lenses
- "Invader Weapons" Observation Sheet
- Art Supplies

TEACHER BACKGROUND ✦

We know from human history that invasions require preparation, strategy, and weapons. Take, for example, the invasions by the infamous Vikings. They traveled to new lands by boat, used their superior weapons to conquer the area, and took the resources of the new land for their own. The process is quite similar for invasive plants. They have strategies that allow them to move rapidly and to claim new territory with a host of very effective weapons. Each plant part could be a potential invader weapon.

Stems:

- Many species of invasive plants grow very quickly, easily overtopping native vegetation. In the south eastern United States, the invasive plant kudzu can grow as much as a foot a day (Souza 2003)! In Alaska, white sweetclover quickly overtops native plant seedlings and dramatically reduces the amount of light available to native plants underneath (Spellman 2008).
- Stems can come in many forms, and many invasive plant species are masters at using modified stems called rhizomes and stolons to clone themselves, reproduce and spread. For example, most invasive grasses can spread not only using their seeds but using rhizomes, their underground stems!

Leaves:

- Many invasive plants use their numerous or large leaves to steal light from native vegetation. In infested areas in south east Alaska, the large leaves of Japanese knotweed easily capture the sunlight before it can reach the plants beneath it.
- Some invasive plants produce chemicals in their leaves that protect them from being eaten by animals. Yellow toadflax, a threatening invader in Alaska, produces a chemical called glucoside that is poisonous to many herbivores (AKEPIC 2005).

Flowers:

- Many invasive plants arrived in an area because they were introduced as ornamental plants. These showy flowers can steal pollinators from native plants.
- We all know that the many flowers of an invasive plant will turn into many seeds. The seeds are really the secret behind invader spread!

Seeds:

- Invasive plants tend to have seeds easily transported by wind, water, animals, or humans. A single orange hawkweed plant can produce up to 600 seeds which can be blown in the wind, stuck on animal fur, or carried in our clothing (AKEPIC 2005)!
- Many species of invasive plants have seeds that last a long time in the soil. White sweetclover seeds can remain viable in the soil for over 80 years (Royer and Dickinson 2004)
- Easy and rapid germination is another secret weapon invasive plants employ. This allows invasives to get a jump start on native plants in the spring. Native plants tend to have more specific germination requirements. Rapid germination also allows invasive plants to come in quickly after a disturbance.

Roots:

- The large root systems of many invasive plant species allow them to monopolize water and nutrients at the expense of the nearby native plants.
- Some invasive plants even change the soil for their own benefit. Nitrogen-fixing bacteria in the roots of bird vetch and white sweetclover allow these invaders to live in soils that don't have many nutrients (AKEPIC 2005). It gives them an advantage over the typically slower-growing plants that are adapted to nutrient-poor conditions.
- Chemical warfare, called allelopathy, is a strategy used by several species of invasive plants. In Alaska, species like quackgrass, Canada thistle, and orange hawkweed secrete chemicals from their roots that poison other plants trying to grow nearby (AKEPIC 2005).

Native plants that specialize in growing after natural disturbances can have many of these similar characteristics (e.g. fireweed). However, because humans have transported the non-native invasive plants so far away from the ecosystems in which they evolved, these non-native plants have the added advantage of having escaped many of their enemies. The wildlife in the new area does not recognize these new plants as food. For example, fireweed, a native plant of Alaska, produces hundreds of seeds; it grows quickly, has many large leaves to capture light, and has showy flowers to attract pollinators. It is a native invader. However, it has a host of insect, mammal, and pathogen predators to keep it in balance with the other plants in the ecosystem. Yellow toadflax, on the other hand, a non-native invader, has many similar adaptations, but it has the added advantage of having very few predators in Alaska to keep it in check. This lesson will allow students to explore the adaptations that give invasive plants a competitive advantage over Alaska's native plants.

ADVANCED PREPARATION ✦

- Assemble materials for the activity and make enough copies of the "Invader Weapons" observation sheet so that each small group of students has a copy.

Create a blank word bank chart on the front blackboard (see example in Table 6.1).

PROCEDURE ✦

1. **(Gear-Up)** Divide the class into groups of four. Pass out a pressed invasive plant sample to each group. Looking at their special plant sample with hand lenses, have groups brainstorm orally in a round-robin fashion one thing they notice about the plant's flower. Repeat the round-robin sharing for the plant's seeds, and again for the plant's leaves. Each group will have a designated reporter to report their observations to the class. Record the observations on chart paper. This chart will become a word bank for students to utilize for their own observation sheets. This activity helps to diversify the instruction and becomes a tool to help students who might have a difficult time with the written language component of the lesson. Table 6.1 illustrates an example word bank chart.

2. **(Generalize)** Were there any descriptions of the plant parts that were similar between the different plants? For example, many invaders have hundreds of tiny seeds. How might the characteristics that all our invasive

plants have in common help these plants be successful invaders in new habitats?

3. **(Explore)** After developing the word bank as a class, hand out the group observation sheets. Groups will have a rotating recorder. The recording student says and then writes one descriptor while the other students coach him or her by agreeing with the description or giving corrective feedback. The pen and paper are then passed to the next student, who has the recording duty and so on. Students will record three descriptors about the plant's flowers, seeds, and leaves. Groups will also sketch pictures of the three plant parts and a picture of the whole plant. Each of three students in the group will pick a plant part to illustrate. The fourth student illustrates the whole plant on the back of the activity sheet or on a separate piece of paper. Give the groups 10 minutes to complete the task.

4. **(Generalize)** Have groups report any new observations they had about their special plant. Respond to the observations reported and fill in the knowledge gaps. Discuss how the different parts of the plant might help make it a good invader. For example, dandelion has hundreds of small wind carried seeds and quackgrass has seeds that stick easily to socks and fur that allow them to invade far-off places and plantain has big leaves that might shade out other plant seedlings.

EVALUATION ✦

Have students design a "Superweed" equipped with super strength invader weapons. These creations can either be drawings or three-dimensional models of the "Superweed." Use clay, model magic, recycled boxes, tubes, string, yarn, or anything you can imagine. With the artistic representation, the students must write a paragraph describing the weed's name (common and scientific names), and the adaptations it has to bully other plants and survive in Alaska.

Table 6.1 An example of the word bank chart.

Plant / Plant part	Dandelion	Quackgrass	Plantain
Flowers	yellow smooth lots of petals	thin alternating seeds looks like wheat	bumpy green round
Seeds	small and fuzzy Like a parachute tons of seeds!	spiky pointed green or brown	Very tiny hundreds! black
Leaves	zig-zag jagged long	long skinny green	oval pointed fuzzy looking

EXTENSIONS ✦

- Go back to the first lesson's charts and reassess some of the preconceptions that the students had about weeds and invasive plants. Try to answer some of the original questions that the students had.

- Have books available on seeds, plants, and invasive plants for students to explore further.

REFERENCES ✦

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Souza, D.M. 2003. *Plant Invaders.* Watts Library—Scholastic Books, New York, NY.

Spellman, B.T. 2008. Impacts of invasive white sweetclover on glacial floodplain plant communities in interior Alaska. Master's thesis, University of Alaska Fairbanks.

Invader Weapons Observation Sheet

Names _____ _____ _____ _____

Invasive Plant Name:

_____

Draw a picture of the flower, seed and leaf of your special invasive weed.

Use a hand lense to get a closer look at each part.

Write describing words about each plant part.

Flower	Seed	Leaf
_____	_____	_____
_____	_____	_____
_____	_____	_____

Lesson 7

Invasives in the Food Web

Grade Level: 1-6
Alaska State Science Standards: SA3.1[3-5], SC2.2[3-6], SC3.2[3-6]
Subject: Science
Target Skills: classification, inference, using time relationships
Duration: 60 minutes, in one or two sessions
Setting: Classroom
Vocabulary: producer, herbivore, carnivore, out-compete, displace, food web, food chain

INSTRUCTIONAL GOAL ✦

Students will understand how invasive plants can disrupt Alaskan food webs.

PERFORMANCE OBJECTIVE ✦

Students will demonstrate the effects of an invasive plant on a few Alaskan food webs in an interactive activity.

MATERIALS ✦

- Yarn — four small balls (approx. 20ft of yarn) per group of six or seven students
- Food Web Wildlife Cards
- Scissors
- Invasives in Alaskan Food Webs Worksheet

TEACHER BACKGROUND ✦

One of the reasons that non-native species are able to become invasive and spread rapidly is that they have reduced enemy pressure in their introduced range. In their native ranges, herbivores and pathogens have evolved and adapted alongside the plants and depend on them as food sources or hosts. In their habitats away from their native ranges, however, the non-native plant has escaped from many of the organisms that keep its population in balance, and if the conditions are right, it can spread out of control. For

example, purple loosestrife (*Lythrum salicaria*) has many herbivores and pathogens that prey on it in its native Europe. Here in North America, nothing feeds on it and it has completely taken over many wetland areas across the continent. It has even begun to spread into wetlands in south central Alaska. Purple loosestrife spreads rapidly and replaces all the native wetland vegetation. You can imagine the devastating impact it has on wetland food webs. In Alaska, purple loosestrife could replace all the aquatic vegetation in a wetland, which could displace the waterfowl. In turn, the displacement of waterfowl could negatively impact the animals that prey on the waterfowl such as foxes and bald eagles. Figure 7.1 illustrates a food chain in purple loosestrife's native range (Krasny et al. 2003). Figure 7.2 shows a food web in an Alaskan wetland. Finally, figure 7.3 illustrates how invasion of purple loosestrife could collapse the wetland food web in Alaska.

White sweetclover (*Melilotus alba*) is one of the most widespread invasive plants in Alaska (AKEPIC 2005). It has spread from roadsides onto river floodplains in many parts of the state, including the Nenana, Matanuska, Stikine, and Healy Rivers (AKEPIC 2005). White sweetclover forms dense stands on areas that normally have open light. The native plant seedlings that need lots of light to grow have to struggle to compete with sweetclover for light. Willows (*Salix* sp.) are among the plants that are impacted by sweetclover (Spellman 2008). Figures 7.4 illustrates an Alaskan floodplain food web and figure 7.5 shows the potential disruption of that food web after the introduction of white sweetclover.

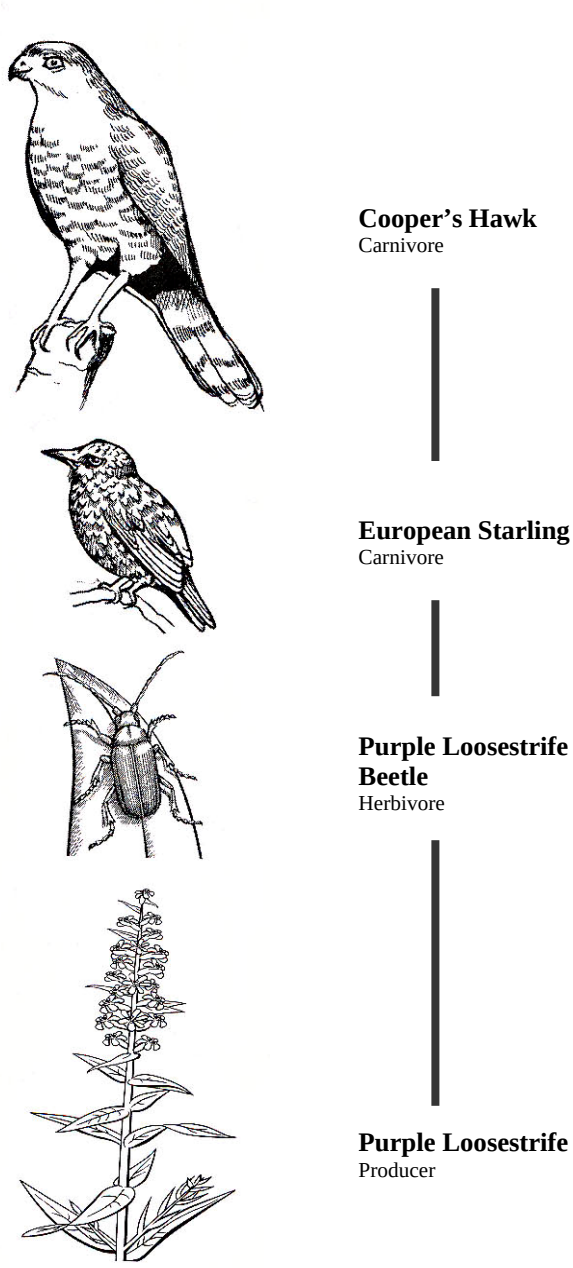

Figure 7.1 A European wetland food chain in purple loosestrife's native range. Predator-prey interactions are represented by solid lines (Krasny et al. 2003).

Please note: The interactions in ecosystems are much more complex than illustrated in these figures. The carnivore, herbivore, producer roles indicated on these figures are the roles played by the organism in these particular food webs. Many of the organisms illustrated here are omnivores (such as the canvasback and red fox) when considering the food sources beyond the simplified food webs illustrated in this lesson. (See figures 7.1 - 7.5)

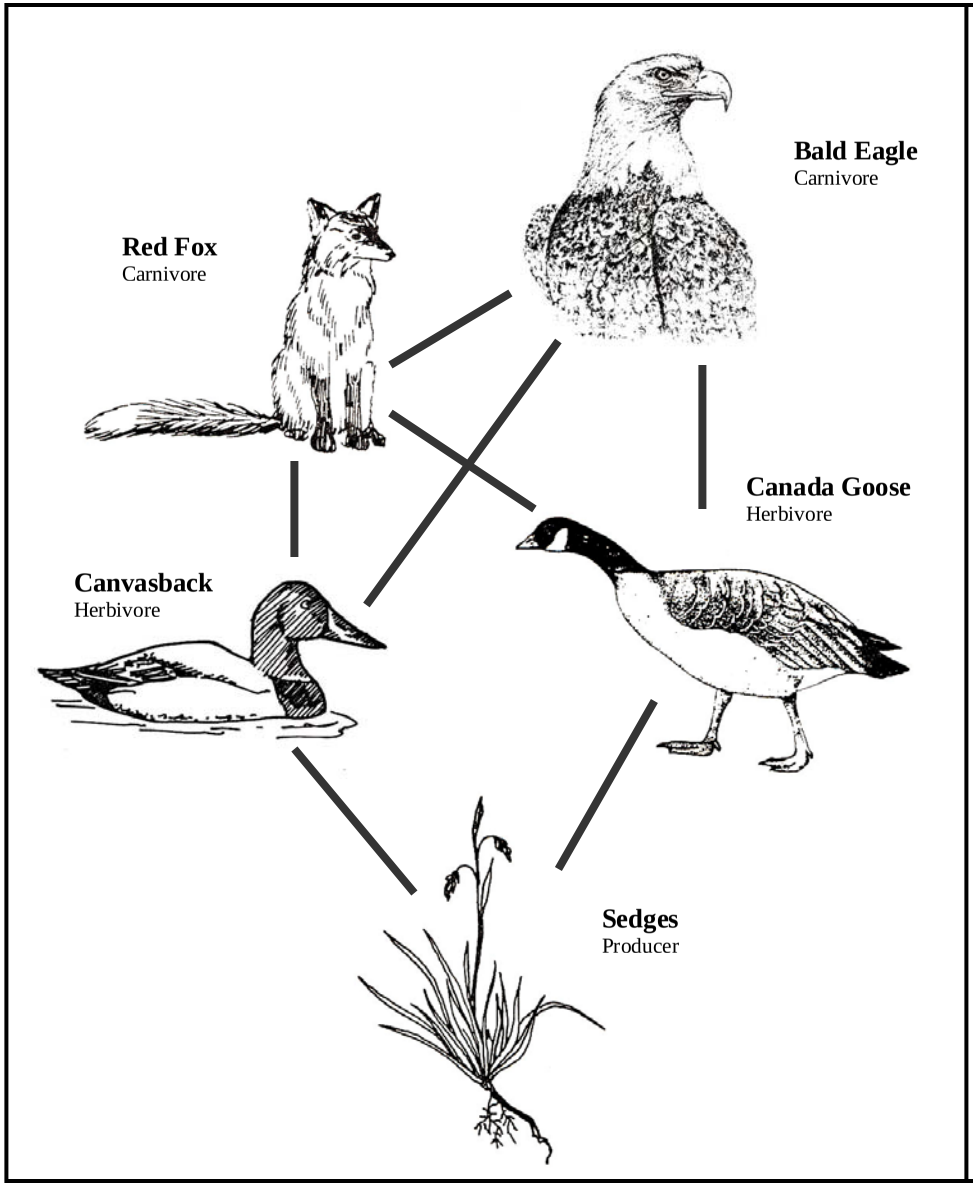

Figure 7.2 An Alaskan wetland food web. Predator-prey interactions are represented by solid lines. Organism drawings reproduced with permission from ADFG (2005).

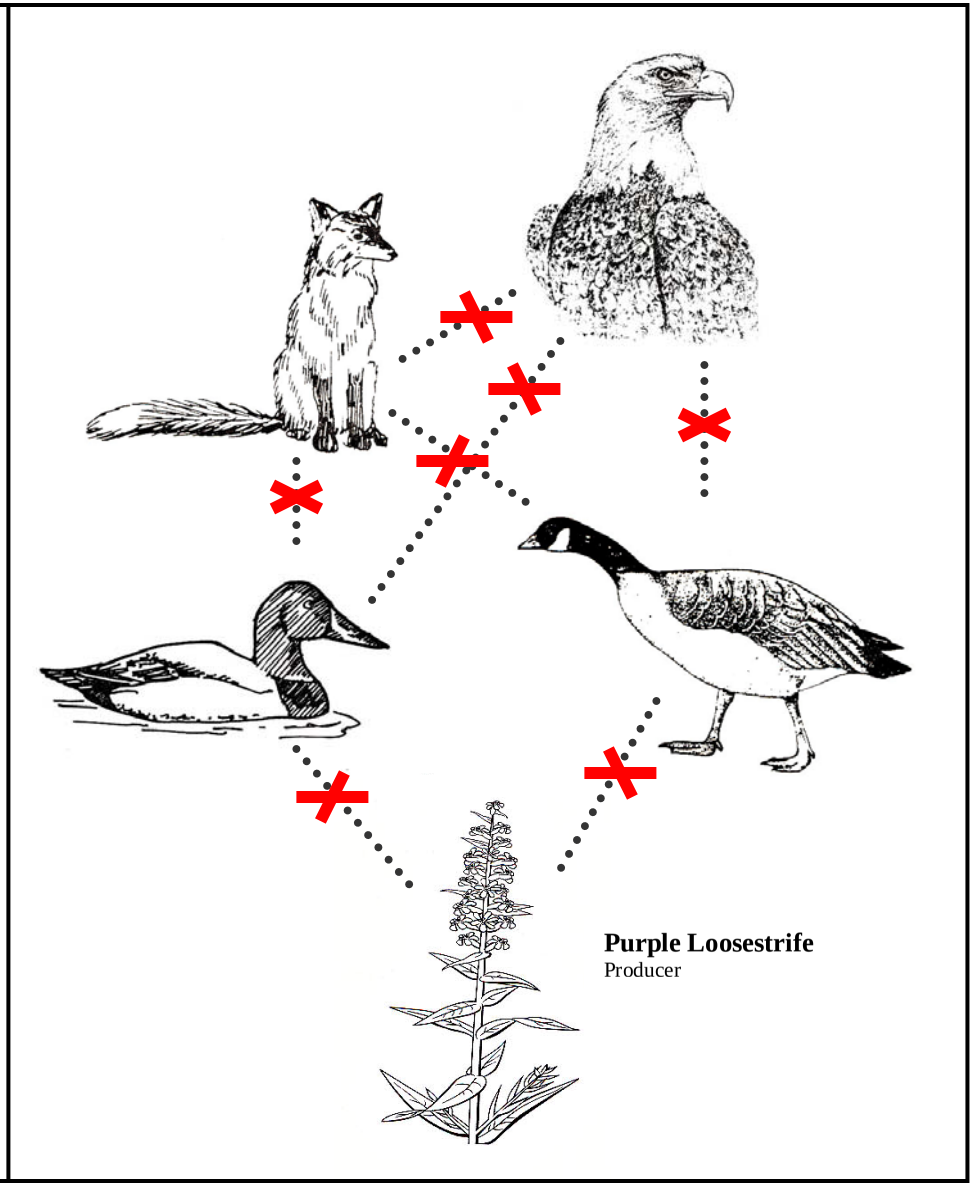

Figure 7.3 An Alaskan wetland food web if purple loosestrife invaded and displaced the native wetland vegetation. Predator-prey interactions that could be disrupted by the invasive species are represented by dotted lines. Organism drawings reproduced with permission from ADFG (2005).

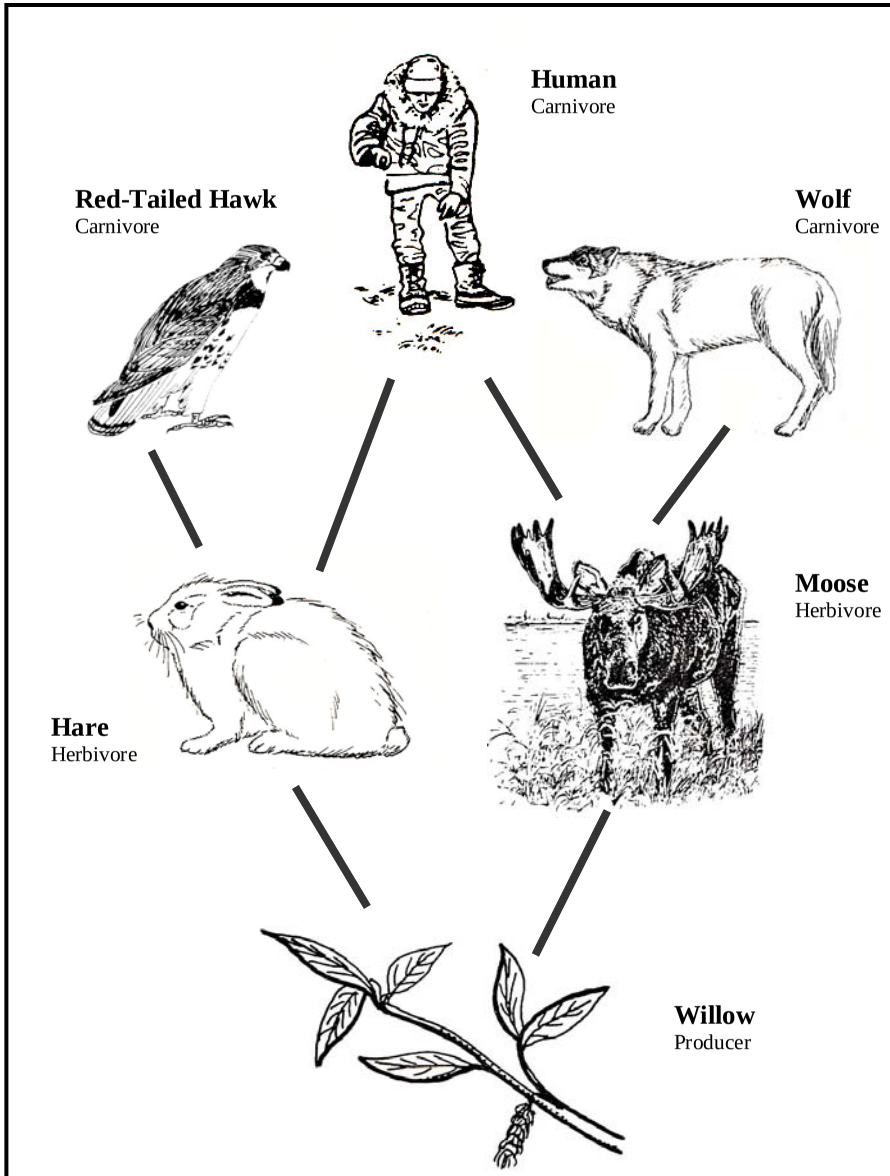

Figure 7.4 An Alaskan river floodplain food web. Predator-prey interactions are represented by solid lines. Organism drawings reproduced with permission from ADFG (2005).

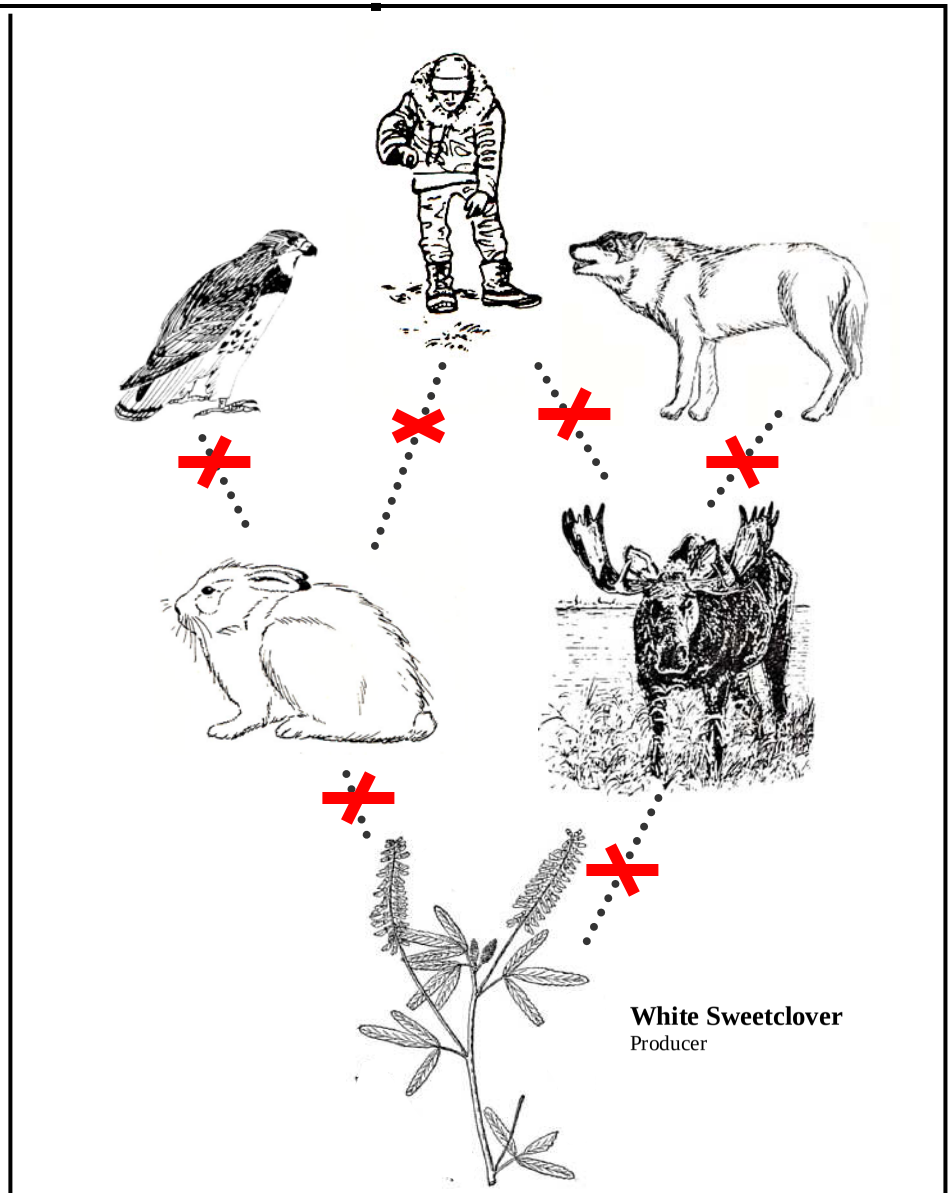

Figure 7.5 An Alaskan river floodplain food web if white sweetclover invaded and displaced the native wetland vegetation. Predator-prey interactions that could be disrupted by the invasive species are represented by dotted lines. Organism drawings reproduced with permission from ADFG (2005).

ADVANCED PREPARATION ✦

- Prepare four small balls of yarn (approx. 20ft of yarn) per group of six or seven students.
- Xerox food web wildlife cards so each group of 6 or 7 students has cards for one food web. Cut and laminate cards, making sure cards from a single food web remain together.

PROCEDURE ✦

1. **(Gear-Up)** A basic understanding of food webs is necessary to conduct this lesson. Offer students working definitions of the following terms: Producer (an organism that makes its food from energy it gets from the sun), Herbivore (an animal that eats plants or other producers), Carnivore (an animal that eats other animals). Have students brainstorm organisms that might fit into each category.

2. **(Explore)** Divide the class into groups of 6 or 7 students. Hand cards from Food Web #1 to groups with 6 students. Hand cards from Food Web #2 to groups with 7 students. Have each group sort their cards into categories: producer, herbivore, or carnivore.

3. **(Generalize)** Have one group representing each of the two food webs report to the class on their classifications and how they knew the organism fit into that specific category.

4. **(Explore)** Within each small group, have students sit in a circle facing each other. Each student chooses one of the food web wildlife cards to represent in their own reconstruction of the food web. The student representing the invasive plant stands up from the circle. The invasive plant will be introduced to the web later in the demonstration.

   Students will use the balls of yarn to show the connections between organisms in an Alaskan food web. Start the balls of yarn in the hands of the carnivores. The number of balls given to the carnivores will equal the number of organisms that it directly eats in the food web (Figures 7.2 and 7.4). For Food Web #1 the bald eagle gets three balls of yarn, and the fox gets one (the second line coming out of the fox will be a continuation of the yarn that is tossed to it by the eagle, who feeds on fox pups). For Food Web #2, the red-tailed hawk gets one ball of yarn, the wolf gets one, and the human gets two. Each ball of yarn will be tossed across the circle to one of the carnivore's prey. The prey will hold on to the yarn, then toss it to the organism that it preys on (in most cases this will be the plant). For example, in Food Web #1, bald eagle will toss a ball of yarn to the canvasback. The canvasback eats sedges, so the student representing the canvasback holds onto the yarn then tosses the remainder of the yarn ball to the sedges. After the four balls of yarn have made it through all possible food chains within the web, all balls of yarn should be in the hands of the plant.

5. **(Generalize)** As the students hold their food web intact, discuss how dependent the different organisms are on each other. In particular, discuss how import the plants are for the whole web. All the balls of yarn ended in the hands of the plants. What would happen if the willows or sedges disappeared? Discuss how invasive

plants can out-compete or displace native plants. Purple loosestrife can easily take over the wetland areas where sedges are abundant. Scientists studying white sweetclover in Alaska have shown that it can reduce the number of willow seedlings that can grow along some rivers. This could displace the willows or reduce the number of willows available for moose and hare to eat.

6. **(Explore)** Hand each of the students representing purple loosestrife and white sweetclover a pair of scissors. These students will demonstrate the dramatic effects that invasive plants could have on Alaskan food webs. Have the students representing invasive plants cut the yarn connections held by the native plants and take their seat in the circle. The native plants have been out-competed or displaced.

7. **(Generalize)** What has happened to the web? Can the canvasback and Canada goose eat the purple loosestrife? No. They must drop their strings and move elsewhere. With the prey gone, what will the eagle and the fox do? They, too, must go find new prey or move to a new habitat. The introduction of invasive plants has caused the food web to break.

*__Adapting Lesson to Early Primary Classrooms:__ This lesson can be easily simplified by demonstrating only a single food chain rather than an entire food web. Reduce Food Web #1 to a single chain by using only **sedge**, **Canada goose**, **bald eagle**, and **purple loosestrife** cards. Reduce Food Web #2 to a single chain by using only **willow**, **moose**, **wolf**, and **white sweetclover** cards. When dividing the class into small groups, each group only needs 4 students and one ball of yarn.

EVALUATION ✦

Have students complete the "Invasive Plants in an Alaskan Food Web" worksheet to review concepts discussed throughout the activity. Worksheets for K-2, and 3-6 students are included in the following pages.

EXTENSIONS ✦

- Discuss methods in which we could prevent or reverse the effects that invasives have on Alaskan food webs. In many places, people have used their knowledge of food webs to help control invasive plants. This is called biological control. In areas where the plants have gotten out of control, people have introduced herbivores that eat the invasive plant in their native range to hold it in check and prevent it from out-competing native plants. How might bringing the purple loosestrife beetle to the wetlands in south central Alaska affect the habitat's food web?

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Spellman, B.T. 2008. The impact of invasive sweetclover (*Melilotus alba*) in early successional floodplain habitats of Alaska. Master's Thesis. University of Alaska Fairbanks, Fairbanks, AK.

***Illustration of purple loosestrife food chain was reproduced from Krasny, M.E., N. Trautman, W. Carlsen, C. Cunningham. 2003. Invasion Ecology. Cornell Scientific Series, NSTA Press, p. 28-32.

***Illustrations of Alaskan wildlife in this lesson are by illustrator Susan Quinlan and are used with permission from Project WILD Coordinator, John Tyson, Alaska Department of Fish & Game, Division of Wildlife Conservation, 333 Raspberry Rd., Anchorage, AK 99518-1599.

Food Web Wildlife Cards

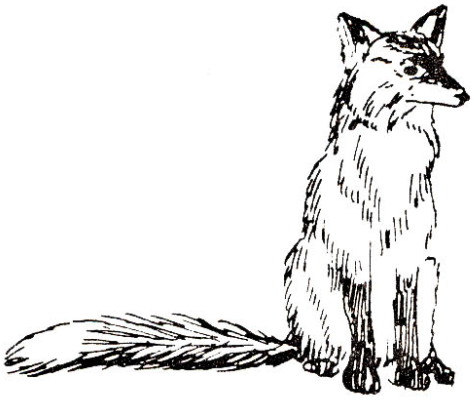
Food Web #1

Food Web #1

Bald Eagle

Food: waterfowl, small mammals, salmon, herring, dead animals, the young of larger mammals such as foxes.

Eaten by: Young occasionally eaten by ravens and magpies.

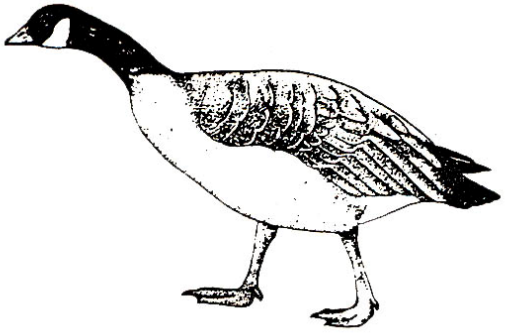


Food Web #1

Red Fox

Food: Geese, ducks, young birds, dead animals, snowshoe hares, small rodents, berries, insects.

Eaten by: Young eaten by eagles. Adults eaten by wolves, lynx, coyotes, and wolverines.

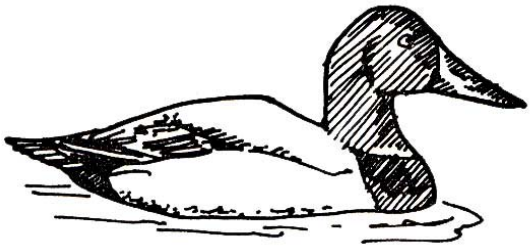


Food Web #1

Canada Goose

Food: Sedges and grasses

Eaten by: Foxes, bald eagles, jaegers, and people.



Food Web #1

Canvasback

Food: seeds of sedges, pondweeds, burreeds, and aquatic invertebrates.

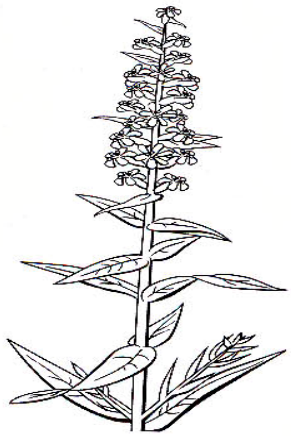
Eaten by: Adults eaten by foxes, falcons, eagles, and humans. Young eaten by foxes, weasels, and gulls.

Food Web #1

Sedges

Food: Make their own by photosynthesis.

Eaten by: Waterfowl such as geese and ducks, many seed-eating birds, large mammals such as muskoxen, and caribou, and many rodents.



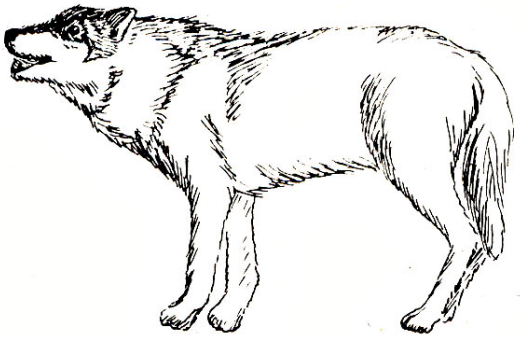
Food Web #1

Purple Loosestrife

Food: Make their own by photosynthesis.

Eaten by: Purple loosestrife beetle in Europe. Nothing is known to eat it in Alaska.

Food Web #2



Food Web #2

Wolf

Food: Moose, caribou, deer, Dall sheep, mountain goats, small animals such as ground squirrels, marmots, voles, and birds.

Eaten by: No regular predators, occasionally eaten by other wolves.

Food Web #2

Human

Food: Moose, caribou, snowshoe hare, ptarmigan, salmon, waterfowl, many plants and domesticated animals.

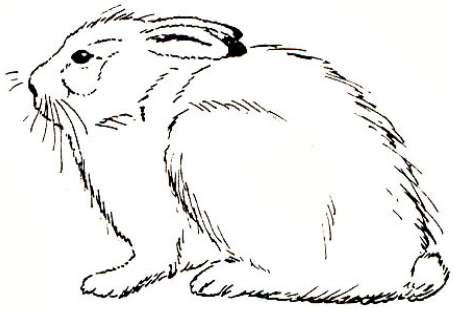
Eaten by: Bears and other large wild animals eat humans on rare occasions, but humans have no true predators.

Food Web #2

Red-tailed Hawk

Food: snowshoe hares, squirrels, voles, mice, shrews, other small mammals

Eaten by: Eggs may be eaten by ravens.

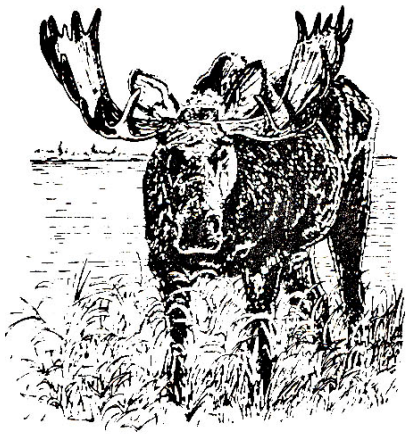


Food Web #2

Snowshoe Hare

Food: Willow and other plants.

Eaten by: Wolves, owls, eagles.



Food Web #2

Moose

Food: Willow, birch, aspen. In summer, grasses, sedges, horsetails, and aquatic plants.

Eaten by: Wolves, brown bear, and humans.

Food Web #2

Willow

Food: Make their own by photosynthesis.

Eaten by: Moose, snowshoe hares, muskoxen, caribou, ptarmigan, redpolls.

Food Web #2

White Sweetclover

Food: Make their own by photosynthesis.

Eaten by: Nothing is known to eat it in Alaska, but people in Yukon Territory, Canada, have seen moose and deer munching it a little.

Name _____

Invasive Plants in an Alaskan Food Chain

Activity Sheet

1. Cut out the Alaskan wildlife below and **paste** them in the correct order on the food chain below.

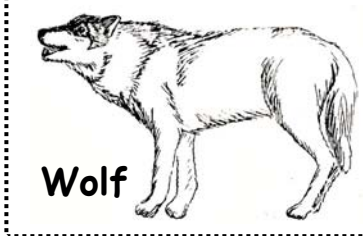
2. At the bottom of the food chain, **draw many white sweetclover plants** taking over the habitat and pushing the willow out.

Carnivore

Herbivore

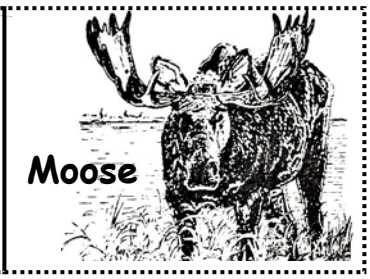
Producer

White Sweetclover



Wolf

Willow



Moose

Name _____

Invasive Plants in an Alaskan Food Chain

Activity Sheet

1. Draw the connections in the Alaskan food web. Draw one or more lines from each animal to the other plants or animals that it eats.

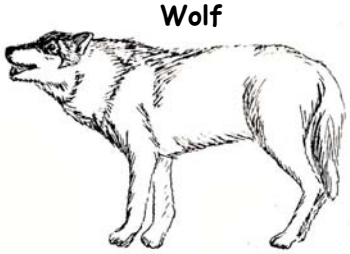
2. At the bottom of the food web, **draw many white sweetclover plants** taking over the habitat and pushing the willow out. Put an X over all the connections that would be threatened if white sweetclover invaded.

Carnivores

Red-Tailed Hawk

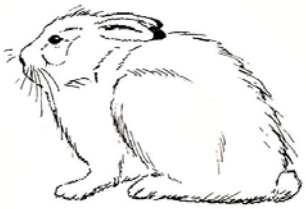
Human

Wolf



Herbivores

Snowshoe Hare



Moose

Producers

Willow

White Sweetclover

Unit 2

Experimenting with Invasive Plants

In the lessons in this section of "WEED WACKERS," students will use science inquiry methods to investigate properties of problem invasive species in Alaska. Do invasive plants in Alaska out-compete native plant species? Do they germinate at higher rates? Do invasive plants and native plants respond differently to different snow depths? Will invasive plants benefit from the projected warmer winters and increased fire disturbances in Alaska's future? Many of the questions investigated in the following lessons are important research questions that scientists in Alaska are only beginning to study. Students become citizen scientists and can contribute their meaningful results to Alaska's understanding of invasive plants in our rapidly changing ecosystems.

Lesson 8

Weed Seed Germination

Grade Level: 1-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA2.1[3-6], SC1.1[3], SC2.1-2.2[3-6], SG2.1[3-6]
Subject: Science, Math
Target Skills: observation, communication, measurement, naming variables, formulating hypotheses, experimentation, inference
Duration: two 40 minute sessions
Setting: classroom and schoolyard
Vocabulary: germination, native, non-native, invasive, hypothesis, procedure, conclusion, swamper, gap grabber

INSTRUCTIONAL GOAL ✦

Students will apply the scientific method to understand differences in native and non-native seed germination.

PERFORMANCE OBJECTIVE ✦

Students will make hypotheses, set up an experiment, collect and interpret data, and extend conclusions to current ecological theory.

MATERIALS ✦

- 2 petri dishes per student
- 2 petri dish-sized circles of quilted paper towel for each student (or 2 petri dish filter papers)
- 10 native Alaskan seeds per student (such as northern bluejoint)
- 10 invasive seeds per student (such as smooth brome)
- Forceps or tweezers to arrange seeds in petri dishes
- Masking tape to label petri dishes
- Water in spray bottles
- Gallon freezer bags to enclose students petri dishes.

TEACHER BACKGROUND ✦

Germination

Germination is the first stage in the life cycle of a flowering plant. Without successful germination, you don't get a plant. Scientific literature from outside Alaska suggests that the seed and germination stage is critical for determining the invasiveness of a plant. In this lesson, students will investigate the differences in germination of native and invasive plant seeds from the same plant family. Do more invasive plant seeds germinate than the same number of seeds that are native to Alaska? Do invasive plant seeds germinate more quickly than native plant seeds? By addressing these questions, students will conduct meaningful experiments and contribute to our understanding of invasive plant germination in Alaska. Be sure to share your students' results with invasive plant researchers in your area (find Alaska invasive plant researchers at http://www.uaf.edu/ces/cnipm/docs/contactdirectory.pdf or contact one of the invasive plant researchers listed at the end of this manual).

Differences in Alien and Native Germination

Rapid and abundant reproduction is one of the key strategies that invading alien plants use to colonize a new habitat. Researchers have identified several qualities having to do with seeds that make a plant a better invader:

1. **Rapid germination-** Alien seeds that germinate faster than the native seeds will have a head start as seedlings. Being a bit larger as a seedling will allow the alien to be better competitors than native seedlings for the available resources. This gives invasive plants the title of "gap grabbers" (Newsome and Noble 1986).

2. **High germination success-** Invasive plant seeds often show increased levels of germination compared to similar native plants. High levels of germination also allow alien invaders to be "gap grabbers."

3. **Large numbers of seeds-** Alien plants that produce thousands of seeds increase their chances of filling up available germination space (Kolar and Lodge 2001). Alien plants are considered "swampers" in this respect (Newsome and Noble 1986). The more space that aliens swamp with their seeds, the less space there is for the native seeds to germinate.

4. **Few pre-germination requirements-** Many plant species have very specific requirements for germination (Fenner 1992). Some plants need specific changes in temperature or light to germinate. Some plants even need chemical cues from the environment to germinate. For example, some seeds only germinate after a fire when smoke is present. Alien plants generally don't have complicated pre-germination requirements, which makes them ready to germinate quickly (Sakai et al. 2001).

5. **Seed size-** Many researchers have found that smaller seeds help plants be better invaders (Baker 1965, Rejmanek and Richardson 1996). Smaller seeds are easily transported by wind and water to new areas. In addition, smaller seed size is tightly correlated with previously described invasive traits

such as higher seed production and few pre-germination requirements. Other researchers have found that larger seed size can also make a plant more invasive (Forcella 1985). Larger seeds tend to germinate faster and tend to be better competitors as seedlings.

6. **Short time between seed crops-** Invasive plants tend to have shorter generation times than similar native plants (Rejmanek and Richardson 1996, Kolar and Lodge 2001), this allows them to continuously saturate the seed bank. This strategy allows the invader to act as both a "swamper" and a "gap grabber" after the next disturbance.

7. **Seeds able to cope with a variety of environmental conditions-** Alien plants must be able to deal with a wide variety of environmental conditions. Biologists call this "physiological plasticity" (Sakai et al. 2001). It is this trait that allows the dandelion to grow everywhere from the tropics to the arctic. The seeds of alien invaders tend to have a wider tolerance to environmental variations than seeds of plants that are adapted to a local climate. This contributes to their comparatively high levels of germination success mentioned earlier. The physiological plasticity of invasive plants in Alaska may allow them to have advantages over native plants as the climate changes.

In this lesson, students will test qualities 1, 2, and 5 with invasive and native Alaskan plant seeds. Quality 7 will be tested in the next lesson.

ADVANCED PREPARATION ✦

- Collect invasive and native plant seeds from plants that belong to the same families. Keep a sample of the whole plant to show the students. Suggestions of common native and non-native plants in the same plant families to choose from can be found in the lesson "Native or Non-Native" of this teacher's guide. For example, use native bluejoint grass seeds and non-native smooth brome seeds from the grass family, or use native northern hedysarum seeds and non-native white sweetclover seeds from the pea family. If using seeds from the pea family, prepare the seeds for germination by gently rubbing them on sandpaper. This is process is called scarification. Many pea family seeds must be scarified for them to germinate.
- **Need help identifying plants and collecting seeds?** Contact one of the invasive plant experts included on the list at the end of this manual.
- Make copies of the "Invasive and Native Seed Germination Experiment" lab worksheet.
- Place a small piece of masking tape on each petri dish so that students can label their dishes with their names and the type of seed.

PROCEDURE ✦

1. **(Gear-Up)** Review concepts from lesson "Invader Weapons: Roots, Leaves, Flowers and Seeds." How can a seed be used as a weapon for an invasive plant to take over an area? Would a "Superweed" have lots of seeds or few seeds, big seeds or small seeds, a long time between seed crops or a short time, seeds that germinate easily in any type of weather or seeds that have specific requirements for germination? Discuss advantages an invasive plant seed might have over a seed from an Alaskan plant.

2. **(Explore)** Hand out seeds from two species of plants in the same plant family, one species that is native to Alaska and one invasive species. Give small cups of seeds to small groups of students. Have the students observe the seeds of two species. How are they different? How are they alike? Which one do they think is the invasive species? Why do they think so? Reveal the identity of the two species. Show a specimen of the plant if you have it available.

3. **(Generalize)** Hand out the "Invasive and Native Seed Germination Experiment" worksheet. Based on their observations of the seeds, have students write hypotheses on which seeds they think will germinate better. Students should think about which will germinate faster and which will have a greater number of seeds that germinate.

4. **(Inquiry)**

Preparing the Experiment:

- Hand out 2 petri dishes and 2 petri dish-sized circles of quilted paper towel (or 2 petri dish filter papers) to each student. Have students write their name on the tape on both their petri dishes, then label one dish "Invasive" and the other "Alaskan."
- While students are labeling their dishes, hand out a pair of forceps and a spray bottle filled with water to each small group of students.
- Have students remove the lids from their petri dishes, place one circle of paper towel into each petri dish, and spray the paper towel three times with the water bottle. Shake any excess water out into a sink.
- Each student should count ten Alaskan and ten invasive plant seeds from the cups of seeds given to each group earlier in the lesson. Handle invasive plant seeds with extreme care! We don't want them spreading on our clothes or shoes accidentally.
- Place the seeds into the appropriately labeled petri dish. Arrange seeds in petri dishes using forceps. Place lids back on petri dishes and seal students' dishes in a plastic freezer bag.
- Allow dishes to sit in a warm place for 7-10 days, checking the dishes daily to make sure the paper towels remain moist. If the paper towel in any of the dishes appears dry, moisten it again with the spray bottle.

Making Observations:

Observe the seeds after 10-14 days. What is happened to the seeds? Students should draw what happened in each petri dish on their "Invasive and Native Seed Germination Experiment" worksheet and count the number of germinating seeds in each dish. When the experiment is over, dispose of the seeds carefully by sealing them in a plastic trash bag. Do not throw seeds outside or in compost.

5. **(Interpret)** Have students draw conclusions from their data. Which type of seed had greater germination? Why do you think this happened? Was your hypothesis correct? Were you surprised? Have students record their conclusions on their experiment worksheet. Continue discussion of results by considering changes they would make to the experiment. What would you do differently? Do you have any new questions? What do you think would happen if you used different species? Do you think the seeds of all invasive plant species would act the same? Why or why not?

EVALUATION ✦

The completed "Invasive and Native Seed Germination Experiment" worksheet serves as an evaluation for this lesson.

EXTENSIONS ✦

- Gather class results and calculate the average germination rate of the invasive and native seeds. Compare the two averages by creating a bar graph.

- Compare the germination of invasive and native plant seeds under different climatic conditions (See the following lesson "Weed Seeds and Alaska's Changing Climate").

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Rejmanek, M., and D.M. Richardson. 1996. What attributes make some plant species more invasive? *Ecology* 77, 1655-1661.

Sakai, A.K., et al. 2001. The population biology of invasive species. *Annu. Rev. of Ecol. Syst.* 32: 305-332.

Williamson, M.H. and A. Fitter. 1996. The characters of successful invaders. *Biol. Conservation* 78: 163-170.

Name_____

Invasive and Native Seed Germination Experiment

Question:

Which type of seeds germinates better, invasive seeds or Alaskan seeds?

Hypotheses:

Do you think there will be a difference between the germination of the invasive seeds and the Alaskan seeds? Why?

_____

_____

_____

Procedure:

- **Put a circle of paper towel in 2 Petri dishes.**
- **Wet the paper towel and pour out any extra water.**
- **Put 10 invasive seeds in one dish and 10 Alaskan seeds in the other dish.**
- **Leave dishes in a ziplock bag for 1 week.**

Results:

Draw what you see in your dishes.

Invasive Seeds

Alaskan Seeds

Count the number of seeds that germinated in each dish.

# of seeds germinated	
Invasive	**Alaskan**

Conclusions:

Which test did the most seeds germinate in? Which germinated faster?

_____

Were you surprised? Why?

_____

_____

Name_____

Invasive and Native Seed Germination Experiment

Question: Will there be more Alaskan seeds or invasive seeds sprouting?

My Guess: Which type of seeds will have more sprouts? Circle one.

Invasive Seeds

Alaskan Seeds

I think my guess is right because…

_____

_____

The Test:

- **Put a circle of paper towel in 2 Petri dishes.**
- **Wet the paper towel and pour out any extra water.**
- **Put 10 invasive seeds in one dish and 10 Alaskan seeds in the other dish.**
- **Leave dishes in a ziplock bag for 1 week.**

Results:

Draw what you see in your dishes.

Invasive Seeds **Alaskan Seeds**

Count the number of seeds that germinated in each dish.

# of seeds germinated	
Invasive	**Alaskan**

Conclusions:

Circle the type of seeds that had the most sprouts.

Invasive Seeds **Alaskan Seeds**

My guess was (circle one) correct. a total surprise.

I think invasive / Alaskan seeds sprouted the most because

_____ .

Lesson 9

Weed Seeds and Alaska's Changing Climate

Grade Level: 1-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA2.1[3-6], SA3.1[3-6] SC1.1[3,4], SC2.1-2.2[3-6], SC3.1[3,4], SG2.1[3-6]
Subject: Science, Mathematics, Technology
Target Skills: observation, measurement, naming variables, formulating hypotheses, experimentation, inference
Duration: two 60 minute sessions, 4-8 weeks apart
Setting: classroom and a snowy winter schoolyard
Vocabulary: insulation**,** germination, climate change, perennial, treatments

INSTRUCTIONAL GOAL ✦

Students will apply the scientific method to understand differences in native and non-native seed germination in different climatic conditions.

PERFORMANCE OBJECTIVES ✦

1. Students will use a snow depth gradient in their winter schoolyard to test if winter temperature influences the germination of native and invasive plant seeds.

2. Students will make hypotheses, set up an experiment, collect and interpret data, and extend conclusions to Alaska's changing climate.

MATERIALS ✦

- Access to a freezer
- Two thermometers (^{o}C)
- Mitten

- 2 petri dishes per pair of students
- 2 petri dish-sized circles of quilted paper towel for each pair of students (or petri dish filter papers)
- 10 native Alaskan seeds per pair of students
- 10 invasive seeds per pair of students
- Forceps or tweezers to arrange seeds in petri dishes
- Masking tape to label petri dishes
- Water in spray bottles
- Gallon-size plastic freezer bags to enclose student petri dishes
- Neon flagging tape to mark study locations
- Snow shovel
- Meter stick

TEACHER BACKGROUND ✦

This lesson is designed to be preceded by the "Weed Seed Germination" inquiry lesson. In this lesson, students will extend their newly gained knowledge of native and non-native plant germination to investigate the influence of winter climate on the germination of these two components of the Alaskan flora.

In this experiment, students will use natural snow depth gradients in their schoolyard to subject native and invasive plant seeds to a variety of winter temperatures. In Alaska, snow acts as an insulator for the ground. The deeper that the snow layer is, the warmer the ground surface temperature. Imagine the snow as a blanket holding in the heat produced by the earth. Using different snow depths around your school grounds, you can simulate the effect of warmer or colder winters on the germination of native and invasive seeds. If we continue to have warmer winters in Alaska, as projected under the current climate models, will invasive plants have an easier time germinating and establishing in our habitats? Most invasive species in Alaska evolved in places that are much more temperate than Alaska. It was thought for a very long time that invasive plant species would have a hard time establishing in Alaska due to our short growing seasons, cold winters, and large areas dominated by permafrost. However, some non-native plant introductions have been successful outside of the species' expected climatic zones (Elven and Elvebakk 1996; Carlson and Shephard 2007). In addition, warming arctic and sub-arctic temperatures have lengthened growing seasons (Myneni et al. 1997), increased winter temperatures (Chapman and Walsh 1993), and changed permafrost in Alaska, all of which might offer a more hospitable environment to invasive plant species.

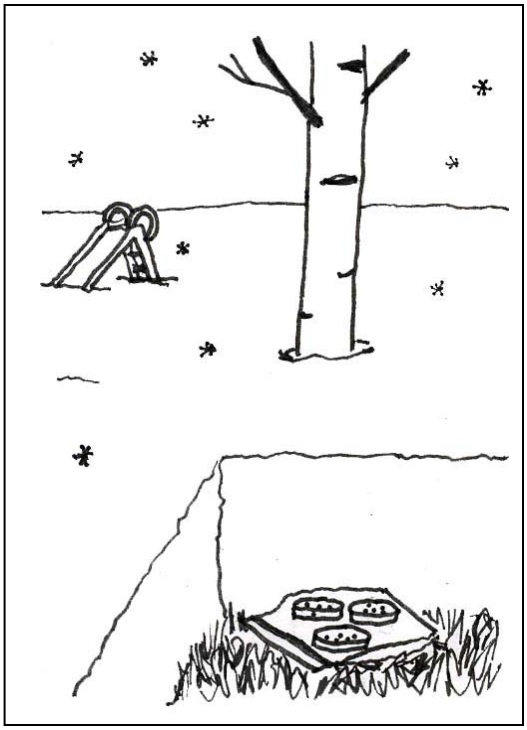
Our understanding of invasive plant response to climate change in Alaska is currently very limited. Students completing this lesson will be gathering valuable data that will contribute to our understanding of the interaction between winter climate and invasive plant germination in Alaska. Be sure to share your students' results with invasive plant researchers in your area (find Alaska invasive plant researchers at http://www.uaf.edu/ces/cnipm/docs/contactdirectory.pdf or contact one of the invasive plant researchers listed at the end of this manual). This lesson was adapted from current research being conducted at the Bonanza Creek LTER by Katie Villano, Blaine Spellman, and Dr. Evan Kane.

ADVANCED PREPARATION ✦

- Scout four locations with varied snow depths (high, medium, low, and no snow) on your school grounds for study sites. Sites must be in areas where they will not be disturbed by

other students, or school groundskeepers. The deep snow site can be found in open, tree-less areas, or down-wind sides of fences and hills. Shallower snow sites can be found under trees, near building awnings or picnic tables, or on the windward side of fences and hills. Sites without snow can be under building awnings. You can also create your own snow depth gradient by shoveling snow from one area (creating shallower snow depths) and dumping it into a big pile (creating deeper snow depths). Mark sites with sticks and neon flagging tape.

- Collect invasive and native plant seeds from plants that belong to the same families. Keep a sample of the whole plant to show the students. Suggestions of common native and non-native plants in the same plant families to choose from can be found in the lesson "Native or Non-Native" of this teacher's guide. For example, use native bluejoint grass seeds and non-native smooth brome seeds from the grass family, or use native northern hedysarum seeds and non-native white sweetclover seeds from the pea family. If using seeds from the pea family, prepare the seeds for germination by gently rubbing them on sandpaper. This is process is called scarification. Many pea family seeds must be scarified for them to germinate. It is advisable to use the same species that the class investigated in the previous lesson "Weed Seed Germination."
- **Need help identifying plants and collecting seeds?** Contact one of the invasive plant experts included on the list at the end of this manual.
- Make copies of the "Weed Seeds and Winter Climate Experiment" lab worksheet.



- Place a small piece of masking tape on each Petri dish so that students can label their dishes with their names, the type of seed, and the snow depth treatment.

PROCEDURE ✦

1. **(Gear-Up)** In front of the class, demonstrate the concept of insulation. Take two thermometers. Put one in a mitten, and have one stand alone. Tell the students you are going to put both thermometers in the freezer for five minutes or outside when it is cold. Which one do you think will have a lower temperature reading after five minutes, the thermometer in the mitten, or the thermometer on its own? Why do you think this? Put the thermometers in the freezer and have a student time the five minutes.

   Meanwhile, explain how climate is changing in Alaska, and how the polar latitudes are being affected at a much

more rapid pace than the rest of the globe. Scientists predict that a warmer climate in Alaska will offer a more hospitable climate to invasive species that adapted in warmer places. In the past, winter temperatures were thought to be too cold for many of the invasive species that we have in Alaska today. We know now that this is not true. The plants are spreading rapidly! What we don't know, is if warmer winters will allow invasive plants to do even better in Alaska. Will they germinate with even greater success? Will seedlings of perennial species (species that can come back every year without needing to start from seed every year) have an easier time surviving the winter? Someone needs to investigate these questions to help Alaskans understand how invasive plants might act as our climate continues to warm. Why not the students right here in this classroom?! We can be cutting edge climate and invasive plant scientists!

2. **(Explore)** Retrieve the thermometers from the freezer or from outside. Which thermometer reads a colder temperature? The one in the mitten, or the one with nothing? Why did the mitten keep the one thermometer warmer?

3. **(Generalize)** Discuss insulation. The mitten was able to keep the thermometer warmer because it trapped the warmer air inside of it and prevented the cold air in the freezer from cooling the thermometer inside the mitten as quickly as the thermometer with no mitten. This is the same reason why the mitten keeps your hand warm outside. It traps the heat produced by your body and insulates you from the cold air outside. Even though snow is frozen water, it actually acts like a big mitten or blanket over the ground.

4. **(Explore)** Investigate the insulating power of snow by setting a thermometer under a thick layer of snow and leaving a second thermometer in open air outside. Which one do you think will read a warmer temperature after an hour? Why do you think? Leave thermometers for an hour, perhaps over lunch and recess, then retrieve the thermometers and immediately read the temperatures.

5. **(Generalize)** What happened? Did snow act as an insulator like the mitten did? Why do you think this happened? Snow is a good insulator because it traps lots of air between the layers of snow crystals. The earth is always producing its own heat, and the snow traps that heat and keeps it close to the ground surface. The temperature of the ground under the snow is actually much warmer than the temperature of air on virtually every day of the winter in Alaska. The thicker the layer of snow, the better it insulates, and the warmer the ground temperature. If you wanted to investigate native and invasive plant germination at different winter temperatures, how could you use snow to create different temperatures?

   If you wanted to simulate a warmer winter in Alaska, should you put the seeds under deep snow or shallow snow? Students will investigate the question, "Does winter temperature influence the germination of native and invasive plant seeds?" To test this they will use sites with different snow depths to simulate different winter

temperatures. Students will put petri dishes with seeds in them under the snow for 4-8 weeks (as time allows), and then return them inside to germinate.

6. **(Inquiry)** Hand out the "Weed Seeds and Winter Climate Experiment" worksheet. Looking at the table in the results section of the worksheet, have students name all the variables investigated in this experiment: snow depth, temperature at the ground surface, number of invasive seeds germinating, number of Alaskan seeds germinating. Is there a control for this experiment? The petri dishes under 0 cm of snow can serve as a control, and the results from the previous lesson's germination experiment can serve as a control. Those seeds were not over-wintered outside.

7. Have students write hypotheses for the experiment on their worksheet. Do they think that seeds will germinate better after a treatment with warmer winter temperatures under deep snow, or after colder winter temperatures under shallow snow? Why? Will the native and invasive seeds respond differently to the winter temperature treatments? Which will germinate better after a time in cold temperatures, invasive plants that evolved in warmer climates, or native plants adapted to Alaska's climate?

8. Students will work in pairs to prepare a set of native and invasive seed petri dishes in the same manner as in the previous lesson "Weed Seed Germination." Please see that lesson for detailed direction on how to prepare germination petri dishes. In order to replicate each treatment, three pairs of students will put their invasive and native petri dishes in the same location. Students should label their petri dishes with their names, native or invasive, and the snow depth treatment (high, medium, low, or no snow). Seal petri dishes for each snow depth treatment in a ziplock bag.

9. Take students, petri dishes, snow shovel, and thermometers outside. At each previously scouted site, measure and record the snow depth. Dig a small hole down to the ground surface. Insert the thermometer at the ground surface into the snow bank. Measure and record the temperature. Insert the bag of petri dishes under the snow at the soil surface and fill the hole back up with snow. Mark the sites clearly with sticks and neon flagging tape.

10. Let the dishes sit under the snow for at least a month. The longer the time period the petri dishes are left outside, the more potential for the treatment to effect germination. This is a great experiment to set up before the winter holiday vacation and to return to in January or February.

11. After 4-8 weeks, collect the dishes and allow the seeds to germinate in the classroom (allow 10-14 days). Make sure the paper towel circles remain moist. Have students observe their petri dishes and record the numbers of seeds that germinated on the "Weed Seeds and Winter Climate" observation sheet. When the experiment is over, dispose of the seeds carefully by sealing them in a plastic trash bag. Do not throw invasive seeds outside or into compost.

12. Gather data from each pair of students and record it on the data table. Have

students calculate average number of germinating seeds for native and invasive plants in each winter temperature treatment.

13. **(Interpret)** As a class, discuss the questions in the conclusions section of the experiment worksheet. Was there a difference between the germination of native and invasive plant seeds under the different winter temperature treatments? What was the difference? Why do you think this happened? Did invasive plant seeds germinate better after being under a lot of snow (warm winter temperature) or under no snow (cold winter temperature)? Why do you think this happened? Based on the class results, do you think that invasive plants in Alaska will benefit from warmer winter temperatures? Why or why not? Students should write their own answers to these questions on their lab worksheet.

14. **(Apply)** Think about situations where snow depth is altered and ask students to extend their findings to other scenarios. For example, which habitat would have higher invasive plant germination, a deciduous forest with lots of snow able to fall through the leafless trees, or a spruce forest with more snow stuck on the trees? Would a roadside with piled up snow from road plows, or an unplowed road have higher winter temperatures at the ground surface? Which would you expect native and invasive plants to germinate better on?

***Adapting lesson to primary classrooms:**

Complete the lesson as described above, but reduce the number of variables that you investigate in this experiment by only using invasive plant seeds. Students can look at the

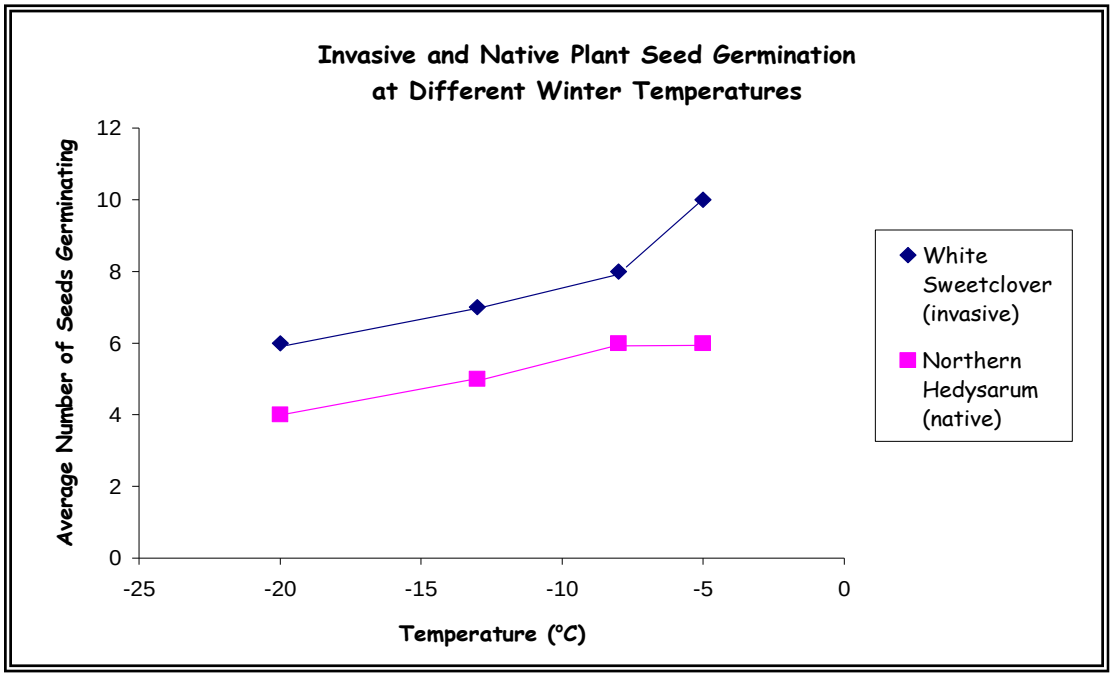


Figure 9.1 Example of a graph used to illustrate the differences in native and invasive plant germination after being exposed to different winter temperature treatments.

influence of winter temperature on invasive plant seeds without comparing them to native plant seeds.

Further simplify the experiment by have each pair of students share a single petri dish. The class should only use three snow depth study sites. There should be the same number of petri dishes in each site so that at the end of the experiment students can fairly compare the total number of seeds germinating after being under the different snow depths. By doing this, you can avoid having to use averages with young students. For a class with 30 students, you should have 15 pairs of students prepare petri dishes of seeds. 5 pairs of students should put their petri dish of seeds under no snow, 5 pairs of students should put their dish under a little snow, and 5 pairs should put them under a lot of snow. When the experiment is over, simply count the total number of seeds germinating after being under each snow depth treatment for the whole class and record the number on the data table and bar graph.

Note: Alaska has diverse winter climates! Adapt this lesson to fit your local conditions. If snow doesn't stick for very long in your area, use other insulators to vary temperature conditions.

EVALUATION ✦

The "Weed Seeds and Winter Climate Experiment" worksheet serves as a written evaluation for this lesson.

EXTENSIONS ✦

- Have students draw a line graph on graph paper or use the excel spreadsheet application, of the native and invasive plant germination under each winter temperature treatment. Figure 9.1 illustrates an example of what this graph might look like. With early primary students, create a simplified bar graph (see observation sheet).
- Use iButtons or other temperature data loggers to make continuous temperature measurements at each of your snow depth sites. iButtons can be left outside for the duration of your experiment to record data automatically. You then bring the data logger inside and download the data onto a computer.
- Share your experiment at a school or district science fair.
- Share your results with local invasive plant researchers. Find Alaska invasive plant researchers at www.uaf.edu/ces/cnipm/docs/contactdirectory.pdf or contact a scientist from the list at the end of this manual.

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Name_____

Weed Seeds and Winter Climate Experiment

Question: Does winter temperature influence Alaskan and invasive seed germination?

Hypothesis:

In which treatment do you think the seeds will germinate the best? Why?

_____

_____

Do you think there will be any difference between the invasive and native seed germination after experiencing the different winter temperatures? Explain.

_____

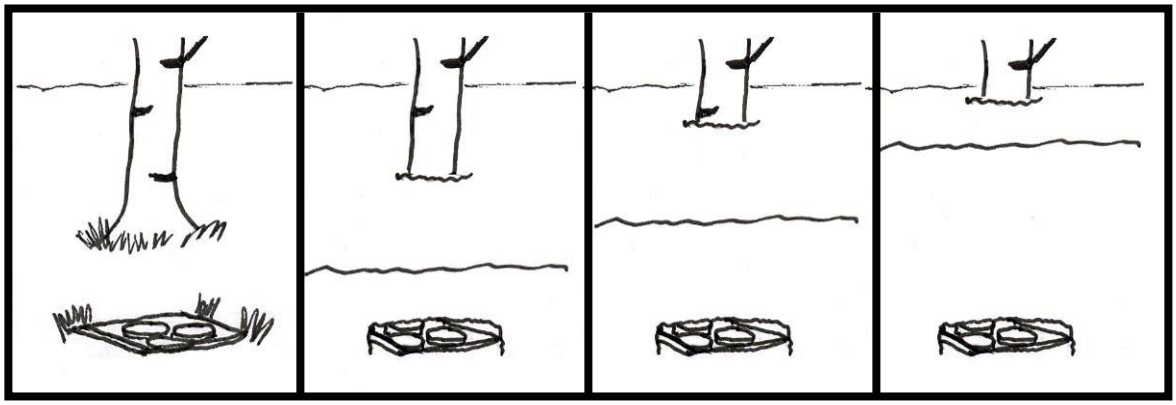
_____

My Treatment:

Partner's Name_____

Our petri dishes are under _____ cm of snow.

The temperature at the ground surface was _____ ^{o}C.



No Snow | Low Snow | Medium Snow | High Snow

Results:

Draw what you and your partner saw in your dishes. Count the number that germinated and write the number on the line.

Invasive Seeds 

_____

Alaskan Seeds 

_____

Class Data:

Snow Depth (cm)	Temperature at Ground Surface (^{o}C)	Petri Dish #	Number of Seeds Germinated	
			Invasive	Alaskan
0		1		
		2		
		3		
		Average		
		1		
		2		
		3		
		Average		
		1		
		2		
		3		
		Average		
		1		
		2		
		3		
		Average		

Conclusions:

Was there a difference between the germination of native and invasive plant seeds under the different winter temperature treatments? What was the difference?

_____

Why do you think this happened?

_____

_____

Did invasive plant seeds germinate better after being under a lot of snow (warm winter temperature) or under no snow (cold winter temperature)?

_____

Why do you think this happened?

_____

_____

Based on the class results, do you think that invasive plants in Alaska will benefit from warmer winter temperatures? Why or why not?

_____

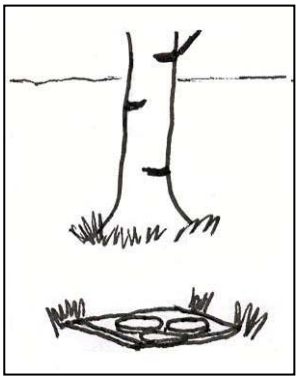
_____

Name_____

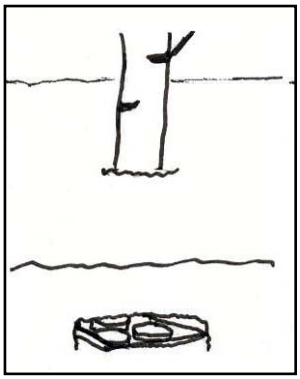
Weed Seeds and Winter Climate Experiment

Question: Does winter temperature influence Alaskan and invasive seed germination?

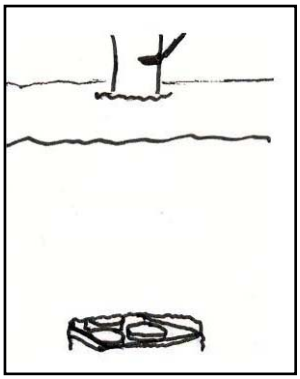
My Guess: I think more invasive plant seeds will sprout after being under… (Circle one)



no snow.



a little snow.



lots of snow.

My Test:

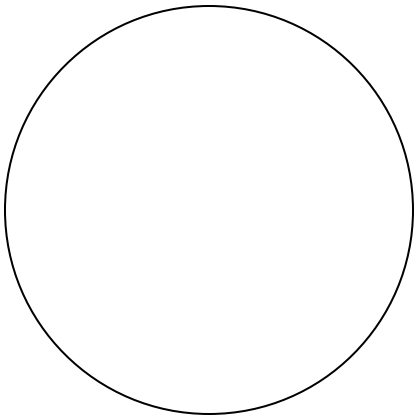
Partner's Name_____

Our petri dishes are under _____ cm of snow.

The temperature at the ground surface was _____ °C.

Results:

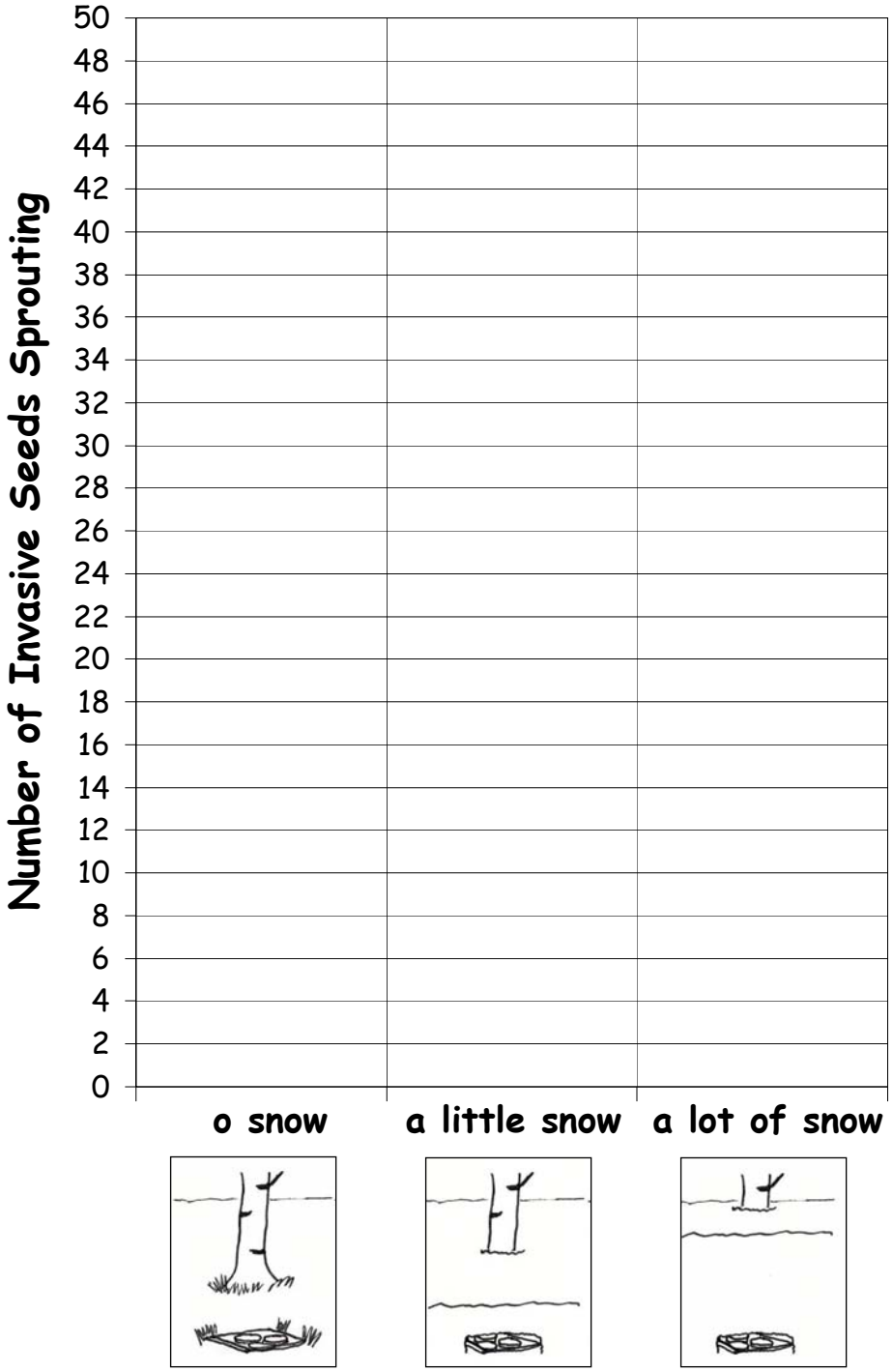
Draw what you and your partner saw in your dish.
Count the number of seeds that sprouted and write the number on the line.



Class Data:

Snow Depth	Temperature at Ground Surface (°C)	Number of Invasive Seeds Germinated
No Snow		
A Little Snow		
A Lot of Snow		

Number of Invasive Seeds Sprouting After Being Under Different Amounts of Snow



*Color the bar graph with your class data. Use a different color for each bar.

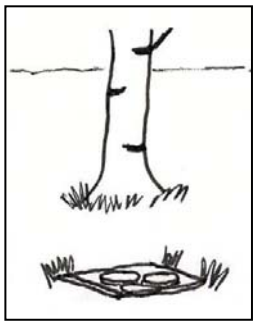
Temperatures: _____°C _____°C _____°C

Our Conclusions:

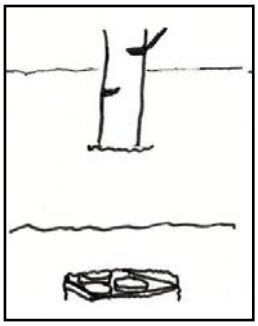
Did the invasive plant seeds sprout differently after being under no snow, a little snow, and a lot of snow? (Circle one)

Yes **No**

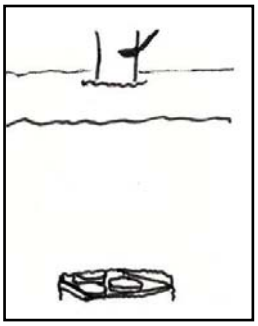
The most invasive plant seeds sprouted after being under which level of snow? (Circle one)



no snow.



a little snow.



lots of snow.

I think this happened because _____

_____ .

Do you now think invasive plants will grow better after cold winters or warm winters? (Circle one)

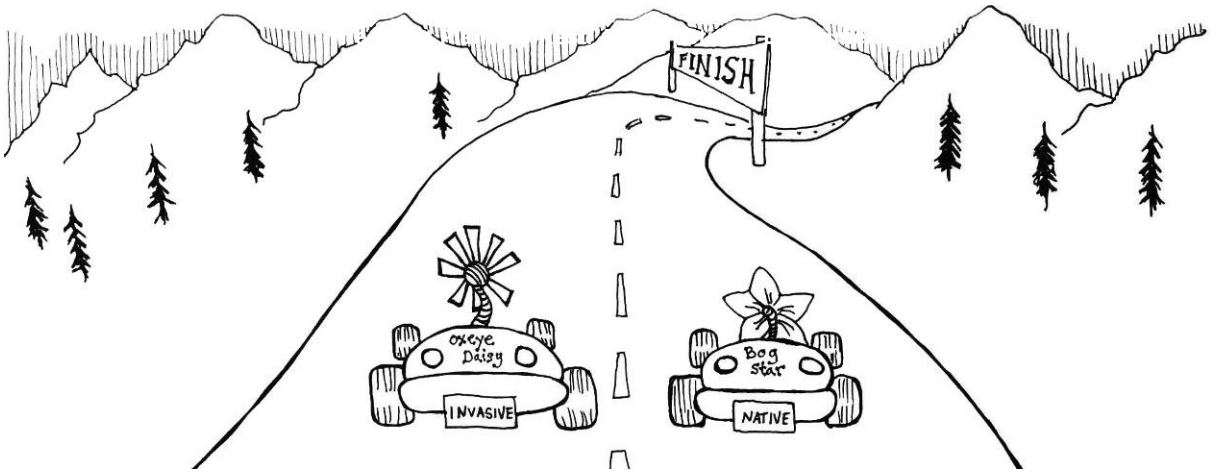
Cold Winters **Warm Winters**

Why will they grow better?

_____

Lesson 10

The Great Plant Contest: A Competition Experiment



Grade Level: 1-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA2.1[3-6], SA3.1[3-6] SC1.1[3,4], SC1.2[3], SC2.1-2.2[3-6], SC3.1[3-6], SG2.1[3-6]
Subject: Science, Math
Target Skills: Observation, measurement, naming variables, formulating hypotheses, experimentation, inference
Duration: two 40 minute sessions
Setting: classroom and schoolyard
Vocabulary: competition, resources, nutrients

INSTRUCTIONAL GOAL ✦

Students will apply the scientific method to understand competition between native and invasive plants.

PERFORMANCE OBJECTIVE ✦

Students will make hypotheses, set up an experiment, collect and interpret data, and make conclusions in an investigation of invasive and native plant competition.

MATERIALS ✦

- *How Plants Survive* by Kathleen Kudlinski, Chelsea Clubhouse Publishers, 2003.
- Small greenhouse pots
- Potting soil
- 5 native Alaskan seeds per student (such as northern bluejoint)
- 5 invasive seeds per student (such as smooth brome)
- Masking tape to label pots
- Water in spray bottles
- Clear plastic trash bag
- Plastic tub of water

TEACHER BACKGROUND ✦

In most habitats, a plant's life is a constant struggle to compete with the surrounding plants for resources such as space, light, nutrients, water, and pollinators. The most successful invasive plants have adapted a variety of strategies to help them compete. As discussed in the lesson "Invader Weapons: Roots, Leaves, Flowers, and Seeds," they can produce thousands of seeds to compete for space, grow big leaves or climbing vines to steal light, send out large root systems to capture nutrients and water, and even steal pollinators at the expense of the surrounding plants. In this lesson, students will observe this great plant contest up close! The class will put an invasive plant species up against a closely related plant species that is native to Alaska, and collect data on the growth of the two species. Which will be the winner? Let the competition begin!

ADVANCED PREPARATION ✦

- Collect invasive and native plant seeds from plants that belong to the same families. Keep a sample of the whole plant to show the students. Suggestions of common native and non-native plants in the same plant families to choose from can be found in the lesson "Native or Non-Native" of this teacher's guide. For example, use native bluejoint grass seeds and non-native smooth brome seeds from the grass family, or use native northern hedysarum seeds and non-native white sweetclover seeds from the pea family. If using seeds from the pea family, prepare the seeds for germination by gently rubbing them on sandpaper. This is process is called scarification. Many pea family seeds must be scarified for them to germinate.

- **Need help identifying plants and collecting seeds?** Contact one of the invasive plant experts included on the list at the end of this manual.

- Assemble planting materials and set up grow light in classroom.

PROCEDURE ✦

1. **(Gear-Up)** Read from *How Plants Survive* by Kathleen Kudlinski, Chelsea Clubhouse Publishers, 2003.

2. **(Explore)** Discuss competition. What resources do plants have to compete for in the environment? What plant parts help plants capture these resources? (Remind students of the concepts from the lesson "Invader Weapons.") Do you think an invasive plant or a plant native to Alaska would be a better competitor? It would depend on the type of plant, right? What if the native and invasive plants were from the same family and were similar in size? If they were grown together would one grow better than the other? Which would be better at capturing resources?

3. **(Generalize)** Make hypotheses and record them on the "Invasive and Native Seedling Competition Experiment" lab worksheet.

4. **(Inquiry)**
   Preparing the Experiment:
   - Fill small greenhouse pots with potting soil. You can also grow your seedlings in paper cups with holes poked in the bottom.

- Moisten the soil by dipping the bottom of the pots or cups in a basin of water for ten seconds.
- Have each student count five Alaskan and five invasive plant seeds. Arrange the seeds in a pattern on top of the soil. If you are using small seeds, like seeds from the aster family plants, cover with very little soil. If you are using larger seeds, like seeds from some of the grass family and the pea family plants, place a thin layer of soil over the seeds (3 – 5 mm thick).
- Spray the top of the soil with a water spray bottle. Students should label their pots with their names.
- Place all pots in a greenhouse tray and then put the tray inside a clear plastic garbage bag. This creates a greenhouse-like environment for the germinating seeds, keeping them warmer and moister than they would be outside the plastic, and increasing the chances of germination.
- Let pots remain in the plastic until the majority of the seedlings have obtained their first true leaf (for monocots the first true leaf is the leaf that emerges after the single cotyledon leaf, for dicots the first true leaf is the leaf that emerges after the two cotyledon leaves). Then allow seedlings to remain under the grow light without the plastic.
- At this point not all the seeds will have germinated. Even the playing field between the native and invasive plants by thinning the plants to the same number of each type of seedling. Three native seedlings and three invasive seedlings is ideal. Do this to isolate competition and eliminate any effects of different germination rates (studied in the previous lesson "Weed Seed Germination").
- Water every day.

Making Observations:

- After the seeds begin to germinate, have students record daily observations. Can they tell which seedlings are the native and which are the invasive? If not, have students look up the appearance of the germinated weed seedling in *Weeds of the Northern U.S. and Canada* by Royer and Dickinson. Are there differences in the seedlings of the invasive plants and the native plants? Which have bigger leaves? Which are taller?
- Once the seedlings look hardy enough to handle without killing, have students make weekly measurements of all their plants.
- Continue observations for 4-8 weeks (as time allows) after the seedlings have their first true leaf. Record observations and measurements of the plants in the data table in the "Invasive and Native Seedling Competition Experiment" lab worksheet.
- When ready to end the experiment, make the final shoot height measurement and then harvest the plants to obtain root measurements. Remove soil and roots from the pots by carefully squeezing the sides of the pot and turning the pot upside down. Gently shake the soil from the roots and measure the root length. If you'd like to measure the dry biomass of the roots, as discussed in the extensions section of this lesson, then float the root mass in a tub of water to gently

rinse any remaining soil off of the roots. Dry the plants in a warm location or in an oven at low temperatures.

- Dispose of seedlings and all soil carefully by sealing them in a plastic trash bag. Do not put soil or seedlings outside or in compost.
- If conducting this experiment with 1st - 3rd grade students skip the root measuring step. However, if you'd like students to see how the different plants might compete for nutrients in the soil, have an adult wash the roots of one or two students' plants. Have students observe any differences in root growth between native and invasive plants.

5. **(Interpret)** Have students draw conclusions from their data. Which type of seedlings grew taller, the native seedlings or the invasive seedlings? Do you think one type of plant competed better for space, soil, water, or light? Why do you think this happened? Was your hypothesis correct? Were you surprised? Have students record their conclusions on their experiment worksheet. Continue discussion of results by considering changes they would make to the experiment. What would you do differently? Do you have any new questions? What do you think would happen if you used different species? Do you think the seedlings of all invasive plant species would act the same? Why or why not?

EVALUATION ✦

The completed "Invasive and Native Seedling Competition Experiment" lab worksheet serves as a written evaluation for this lesson.

EXTENSIONS ✦

- Compare the average final seedling heights and root lengths of the invasive and native plant species by creating a bar graph.
- Compare the changes in average seedling heights of the invasive and native plant species throughout the experiment by creating a line graph.
- Most scientists conducting competition experiments with plants use biomass as their final measurements rather than seedling height and root length. Invite your students to dry their plants and weigh the roots and shoots on an electronic balance.
- Try the experiment with a variety of plant species. Sow two different aggressive invasive plant species in the same pot and see what happens. Can one invader be used to control another?
- Vary the amount of resources available to the pots. What happens to the native and invasive plants when they are grown in a shoe box without light? Does one species do better than the other? What if the pot is only watered once every three days instead of every day? Is the native or invasive plant better at getting the water and surviving? What if you fertilize the pots so there are plenty of nutrients? Which plants would do better?

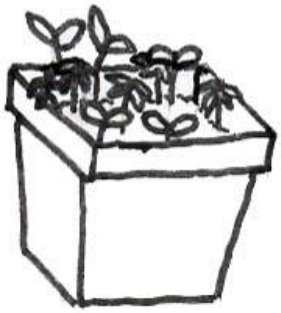
REFERENCES ✦

Kudlinski, K. V. 2003. *How Plants Survive.* Chelsea Clubhouse Publishers, Philadelphia, PA.

Royer, F., and R. Dickinson. 2004. *Weeds of Northern U.S. and Canada*. University of Alberta Press, Edmonton, Canada.

Invasive and Native Seedling Competition Experiment

Name_____



Question:

Are invasive or Alaskan plants better competitors?

Hypotheses:

1. Do you think there will be a difference between the invasive seedlings and the Alaskan seedlings? Explain.

_____

_____

_____

2. Do you think an invasive plant or an Alaskan plant will be a better competitor for space, light, nutrients, and water? How will you know which one is better at getting these things?

_____

_____

_____

Invasive and Native Plant Competition Observations:

Date	Drawing	Notes	Seedling Heights		
			#	Invasive	Alaskan
			1		
			2		
			3		
			Avg		
			1		
			2		
			3		
			Avg		
			1		
			2		
			3		
			Avg		
			1		
			2		
			3		
			Avg		

Root Measurments (to go with final observations):

Root Lengths		
#	Invasive	Alaskan
1		
2		
3		
Avg		

Conclusions:

Which type of seedling grew taller?
(Circle one) **Invasive** **Alaskan**

Which type of seedling had longer roots? (Circle one) **Invasive** **Alaskan**

Do you think one type of plant competed better for space, soil, water, or light? How could you tell from your data?

_____

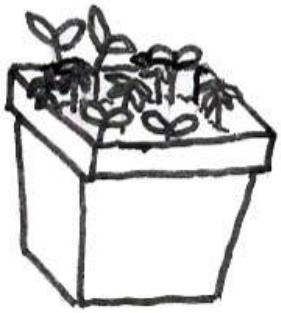
_____

Why do you think this happened?

_____

_____

Invasive and Native Seedling Competition Experiment



Name_____

Question and Hypothesis:

Which type of plant is a better competitor? Circle your guess.

Invasive

Alaskan

How will you know which plant was better at getting light, space, water, and nutrients?

_____

Draw a picture of what you think will happen to the two types of plants when they are grown together in your pot. Which type will be taller? Which will have more leaves? Which will there be more of?

Invasive and Native Plant Competition Observations:

Date _____	Date _____	Date _____	Date _____
Draw what you see.	Draw what you see.	Draw what you see.	Draw what you see.
Write what you see.	Write what you see.	Write what you see.	Write what you see.
Measure the tallest plants.	Measure the tallest plants.	Measure the tallest plants.	Measure the tallest plants.
Invasive = _____ cm	Invasive = _____ cm	Invasive = _____ cm	Invasive = _____ cm
Alaskan = _____ cm	Alaskan = _____ cm	Alaskan = _____ cm	Alaskan = _____ cm

Conclusions:

Which type of seedling grew taller? (Circle one)

Invasive

Alaskan

Do you think one type of plant competed better for space, soil, water, or light? How could you tell from your observations?

_____

_____

_____

Why do you think this happened?

_____

_____

Lesson 11

New Territory for Weeds: Disturbance and Re-growth in Alaska's Forests

Grade Level: K-3
Alaska State Science Standards: SC1.1[3-5], SC2.1[3,5,6], SC3.1[3-6]
Subject: Science, Language Arts
Target Skills: Communication, Using time relationships
Duration: three to four 40 minute sessions
Setting: classroom and playground or gymnasium
Vocabulary: cycle, disturbance, forest, herb, leafy tree, shrub, spruce, stage, succession

INSTRUCTIONAL GOAL ✦

Students will learn that succession is a process that helps forests be reborn after major disturbance (fire, flood, human disturbances).

PERFORMANCE OBJECTIVES ✦

1. Students will define and sequence the stages of forest succession in an interactive succession card activity
2. Students will perform a dramatization of the forest timeline.

MATERIALS ✦

- Chart paper, overhead projector or LCM computer projector
- Books: *Fire and the Changing Boreal Forest* by Christine and Katie Villano, or *Fire in the Forest: A Cycle of Growth and Renewal* by Laurence Pringle
- Paper and pencil for each group
- 200 meter measuring tape
- Forest succession sequencing cards

TEACHER BACKGROUND ✦

Habitats that have been recently disturbed are particularly vulnerable to colonization by invasive plants. After a major disturbance, competition from other plants is often reduced or eliminated, allowing more resources to be available for invading species. There are many types of disturbance in Alaska. Disturbances can be caused by natural forces or by human activities. Common large-scale natural disturbances in Alaska include fires, floods, permafrost melting (thermo-karsting), and storms. Human disturbances include road construction, clear-cut logging, clearing land for building or agriculture, and any sort of activity that turns up the soil and eliminates most of the vegetation. In the interior of Alaska, common disturbances are fires and floods. On the southern coast of Alaska, storms and logging are more common disturbances than in other parts of the state. In the tundra regions of Alaska, permafrost disturbances and human development (such as construction, airstrips, resource development and exploration) create new potential territory for weeds.

In this lesson, students will learn how forest ecosystems in Alaska recover after disturbances. The pattern of forest regeneration after a disturbance is called **succession**. In most forested areas of Alaska, the pattern is pretty predictable: disturbance, herb phase, shrub phase, young forest (deciduous dominated), mature forest (conifer dominated), old forest (highly flammable old conifers) (USFWS 1995). Figure 11.1 illustrates an example of these phases after a fire. This pattern, of course, is a generalization, and can be altered by climatic variables, geography, slope and aspect, and the frequency of disturbances. If invasive plants come to dominate an area after a disturbance, they too, can alter the successional pattern.

In order to protect Alaska's habitats from the spread of invasive plants, it is important for us to be able to identify areas that might be the most susceptible to invasion (or "invasible"). While very few studies have been conducted on the invasibility of boreal and tundra ecosystems, in other ecosystems, the herb and shrub phases of succession tend to be most susceptible to invasive plant colonization. The graph in figure 11.1 illustrates this pattern. Students will learn about the phases of succession and extend this understanding to the two following inquiry lessons "Invasive Plants and Disturbance: Field Study" and "Invasive Plants and Disturbance: Classroom Experiment."

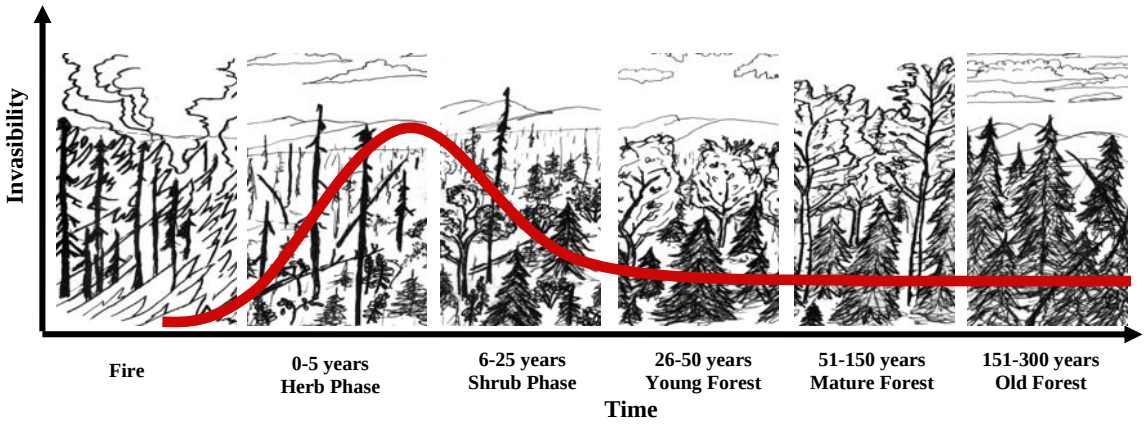


Figure 11.1 General pattern of forest succession (illustrations along x-axis) and forest invasibility (red line).

ADVANCED PREPARATION ✦

- Make a KWL chart on chart paper, overhead projector or computer application (What we **K**now, What we **W**onder, Where we can **L**earn).
- Measure out and label a timeline of climax-driven forest succession outside in a playground, in a long hallway, or in a gym. Each meter equals one year on the forest timeline.
  - **0 meters**- Disturbance (fire, storm, human disturbance, etc.)
  - **1 meters**- Herbs phase
  - **5 meters**- Shrub phase
  - **25 meters**- Young forest phase
  - **50 meters**- Mature forest phase
  - **150 meters**- Old forest phase
  - **200 meters**- Another disturbance
  - **BACK TO 0 METERS**

  This activity can also be done using smaller units if space is limited (e.g. 1 foot = 1 year).

PROCEDURE ✦

1. **(Gear-Up)** Students work in pairs. Each student has 30 seconds to tell the partner what he/she knows about forests and how they grow. Partners take turns telling and listening. Partners share each other's ideas as the teacher records the information on a KWL chart under the K column, "what we **K**now".

2. **(Explore**) Have the students generate questions they have about how forests grow and change. Record their wonderings on the chart in the "what we **W**onder" section. Lead the discussion then to how and where can students can find the answers to their questions. Record these observations in the L column of the chart.

3. **(Generalize)** Read-aloud *Fire and the Changing Boreal Forest* by Christine Villano and Katie Villano or *Fire in the Forest: A Cycle of Growth and Renewal* by Laurence Pringle. Revise and refine student understanding of how forests grow and change through discussion of the book. Display the forest succession picture cards (found at the end of this lesson) that illustrate each stage. Emphasize forests go through life cycles just like animals or plants. A forest's cycle of disturbance and re-growth is called **succession**.

4. **(Explore)** Break into small groups of four to make lists of possible ways forests are disturbed and changed. Give each group one sheet of paper and one pencil. Students will first generate a list of possible types of disturbances. Each group member will propose an idea, get a thumbs-up approval from the other group members, record their idea, and then pass the paper and pencil to the next person. After all group members have contributed to the first list, the group will generate a second list on ways the forest can change after a disturbance. After 5-10 minutes, groups should share ideas with the teacher who can record ideas on chart paper, overhead or LCM, and discuss what the class came up with together. Students write how a disturbance can happen in a forest and how a forest may change because of it in their journals or as a writing extension activity.

5. **(Apply) Alaskan Forest Succession Activity:** Students will act out the stages of forest succession as they walk along the measured and labeled timeline previously set up during the lesson advanced preparation.

Remember, one meter equals one year on the timeline. Figure 11.2 illustrates actions for the various successional stages.

0 meters- Stage 1 FIRE: Students lay down as dead trees.

Teacher: "A fire (or the disturbance most common to your area, e.g. storm, clear-cut, etc.) has burned the forest. Many of the trees have fallen down dead. Black tree skeletons are everywhere. It looks grim and lifeless."

Between meter 0 and 1- between Stage 1-2: Students are crouched over in rolled positions as seeds and underground stems.

Teacher: "Sun and rain come to the forest in the spring and summer. Seeds come into the burn (or other disturbance) and underground plant parts that survived the fire (or other disturbance) begin to grow toward the sun."

1 meter- Stage 2 HERBS: Students remain in a crouched position but stretch their heads up, putting their hands under their chins like budding blossoms**.**

Teacher: "Wildflowers and grasses come back quickly to the forest. Scientists call this stage of the forest's life cycle the herb phase."

5 meters- Stage 3 SHRUBS: Students move along the time line hunched over and holding out their curled hands as short branches to be the shrub growth.

Teacher: "Then comes the shrubs. We see mostly alder, willow, and berry bushes. Alder fertilize the soil with the help of bacteria. Tree seedlings start to grow taller."

25 meters- Stage 4 YOUNG FOREST: Students stand up with arms outstretched to represent leafy trees that are growing tall towards the sun.

Teacher: "After 25 years the tree seedlings that were hiding in the shrubs are finally tall. The young forest has aspen, poplar, and birch trees. They reach for the sun. The spruce trees grow more slowly. This is called a young forest."

50 meters- Stage 5 MATURE FOREST: Students stand as spruce trees with hands over their heads to make a triangle shape as the class continues to move along the timeline.

Teacher: "The spruce trees finally catch up to the leafy trees. They shade out the smaller plants from the sunlight. Moss begins to grow thick again. This is called the mature forest."

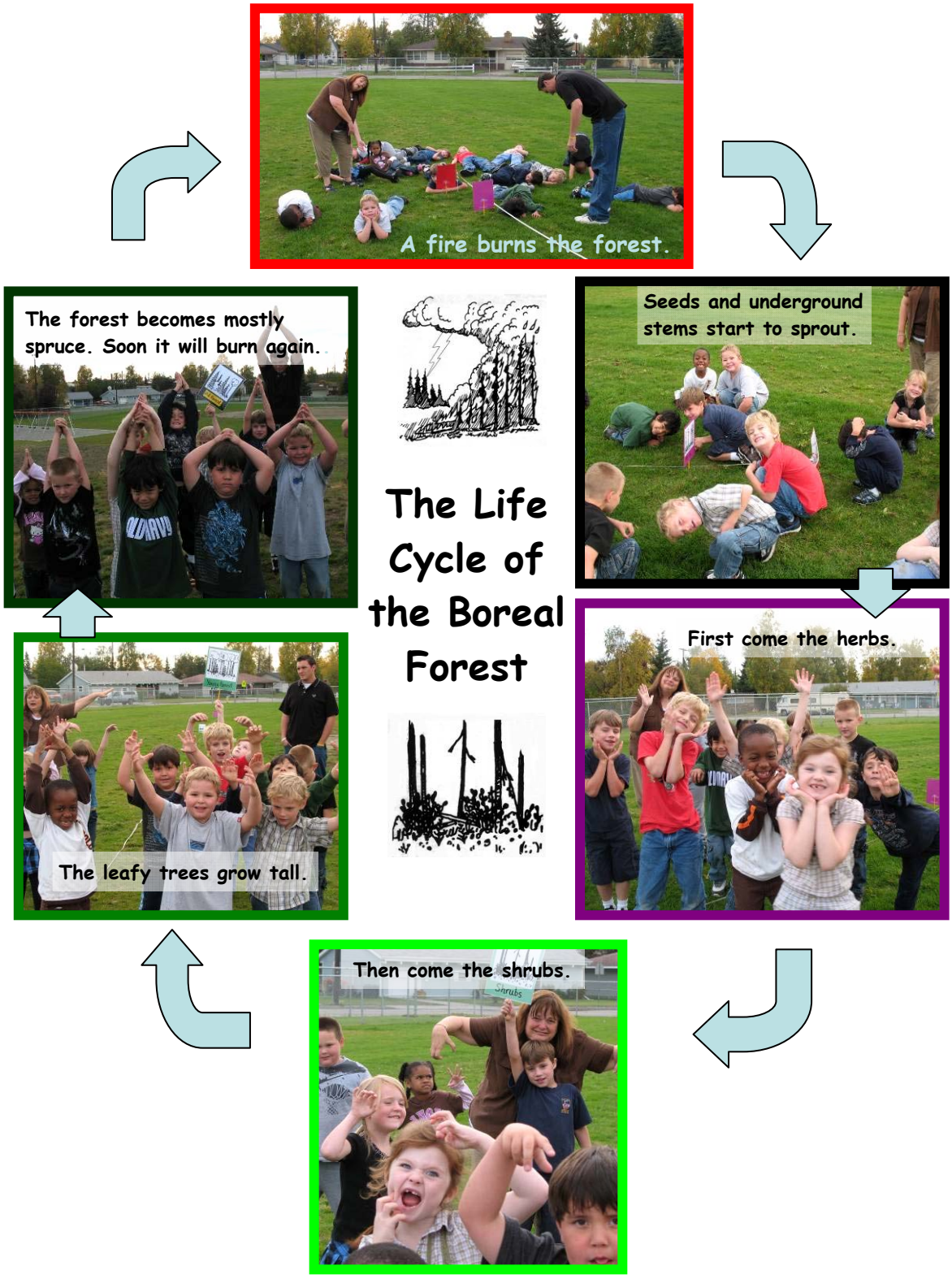
150 meters- Stage 6 OLD FOREST: Students still stand as spruce trees with hands over their heads, but move very slowly, in a tired fashion, toward the end of the timeline.

Teacher: "The forest grows old. The moss covers the soil in thick layers allowing the soil to remain frozen even in the summer. It becomes hard for most plants to live. The spruce and moss are some of the few plants that remain. The forest is ready to burn again."

200 meters- Thunderclap and lightning (or some other dramatic disturbance).

Teacher: "BOOM! CLAP! SPARK! A Fire!!"

Figure 11.2 Denali Elementary students act out the life cycle of a forest after a disturbance.



EVALUATION ✦

- Hand six students one of each forest succession stage sequencing cards. In front of the class, those six students must arrange themselves in order of succession. Each student takes turns explaining what is happening to the forest habitat in the stage of succession that their card represents. Each student then hands their card to another student in the class. The next group arranges themselves in the correct order and explains their stage of succession. Challenge students to not repeat answers given by other students. Differentiate instruction for more advanced students by asking them to explain how the abiotic conditions such as the soil, light, and space change with each stage of succession. Repeat the activity until every student has had a chance to hold a sequencing card in front of the class.

- Create pattern sentences on sentence strips that match each stage of forest succession. Example pattern sentences:

  I see the fire.
  I see the herbs.
  I see the shrubs.
  I see the young forest.
  I see the mature forest.
  I see the old forest.

  On a pocket chart, place the sentences in order and do choral reading of each sentence. Hand out index cards with words from the sentences and have students come up to the pocket chart to find the word and place their card where the word belongs. Hand out forest succession sequencing cards and have students match illustrations with sentence strips. Leave the sentence strips, word cards, and illustration cards available for a literacy learning center for kids to practice with during the day.

EXTENSIONS ✦

- Give small groups of students sequencing cards. Students will take turns sequencing the cards in the correct order of forest succession and explain to the group why they put their card in that particular order. This serves as a quick review for students.

- Have students create a "Life Cycle of the Forest" mobile. Glue forest succession sentences in order in a circle. Hang illustrations of each phase from the sentences. For early literacy classrooms, have sentences and illustrations prepared for cutting and gluing. For older classrooms, have students write their own sentences and hang their own illustrations on the mobile.

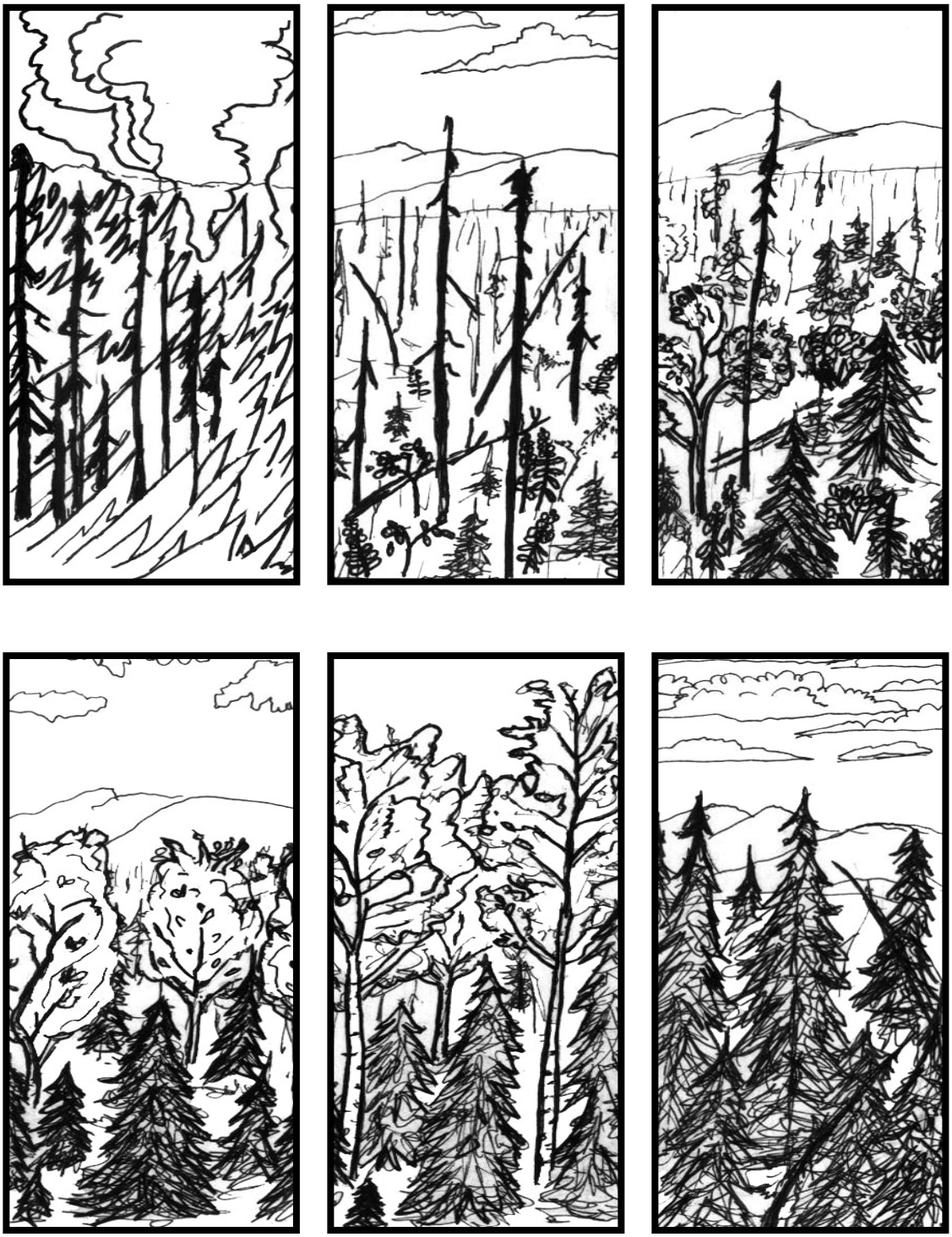
REFERENCES ✦

Villano, K., and C. Villano. 2007. *Fire and the Changing Boreal Forest.* Mini-book available with this lesson.

Pringle, L.1995. *Fire in the Forest: A Cycle of Growth and Renewal Antheneum Books for Young Readers. New York, New York.*

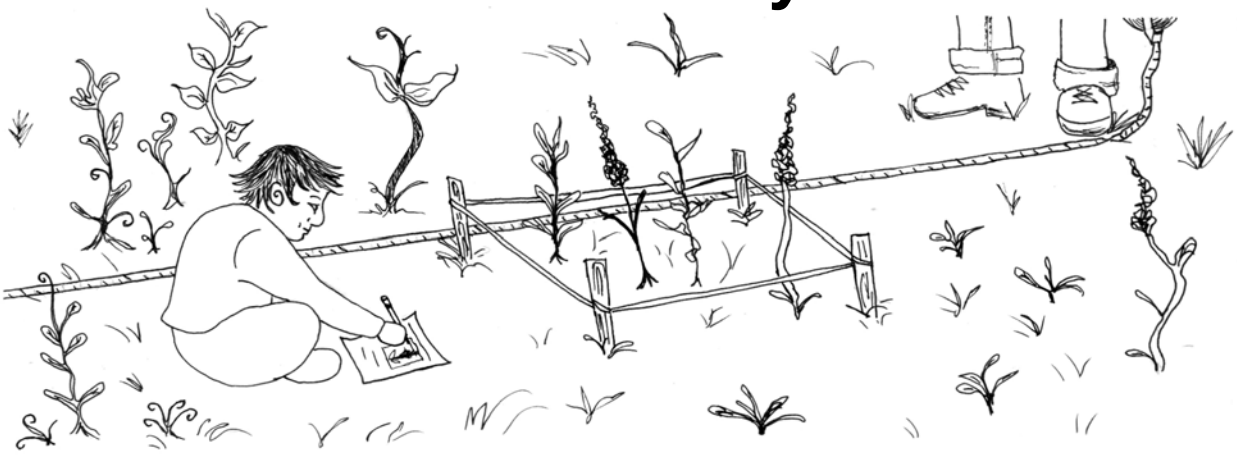
U.S. Fish and Wildlife Service. 1995. *The role of Fire in Alaska* U.S. Fish and Wildlife Service Alaska fire curriculum guide. Anchorage, AK

Boreal Forest Succession Sequencing Cards



Lesson 12

Invasive Plants and Disturbance Field Study



Grade Level: 1-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA2.1[3-6], SA3.1[3-6], SC1.1[3-5], SC2.1-2.2[3-6], SC3.1[3-6], SG2.1[3-6]
Subject: Science, Art
Target Skills: observation, communication, measurement, inference, prediction, naming and controlling variables, formulating hypotheses, collecting and interpreting data, experimentation
Duration: 2 hours in the field, classroom wrap-up 30-60 minutes
Setting: a field site with disturbed and undisturbed habitats
Vocabulary: non-vascular, herbs, trees, shrubs, transect, quadrat

INSTRUCTIONAL GOAL ✦

Students will understand the role of disturbance in invasive plant abundances through an outdoor inquiry.

PERFORMANCE OBJECTIVES ✦

1. Students will conduct a field study to compare invasive plant abundances in undisturbed and disturbed habitats.
2. Students will make detailed observations of both habitat types, survey invasive plants along a transect, record data, and interpret their results.

MATERIALS ✦

- Measuring tapes
- 50 cm x 50 cm quadrats (available in WEED WACKERS kits, or easily constructed out of 50 cm sections of PVC pipe or string tied to stakes)
- Field study worksheet
- Clipboards
- Pencils
- Adult chaperones

TEACHER BACKGROUND ✦

Natural disturbances are an important part of ecosystem functioning. For example, in the widespread black spruce forests across Alaska, fire disturbances are essential for renewing the ecosystem and putting nutrients back into the soil (Chapin et al. 2002). Disturbances also offer prime habitat for most invasive plants, which thrive in high nutrient, high light conditions (Hobbs and Huenneke 1992). In this lesson, students will study a disturbed field site (disturbed either by natural forces or by human activity) and an undisturbed field site. They will compare the types of plants growing in each site, as well as compare the ground surface, soils, and light availability.

To investigate the differences between plant communities, scientists often use larger groupings of plants to simplify their surveys and analysis. One common way to group plants is by their growth form: **trees, shrubs, herbs, nonvascular plants** (plants with no tubing to transport water and nutrients). These groupings are also sometimes referred to as plant functional types. This is because these growth forms often correlate to their function or job within an ecosystem (Chapin et al. 2002). The students will use these plant groups to describe the vegetation in their field sites. Table 12.1 shows how to tell the plant types apart. The students will use their knowledge from the two previous lessons, as well as their field observations to predict whether the disturbed or undisturbed site will have higher abundances of invasive plants growing in it. Students will then use a transect to sample the abundances of invasive plants in each site. If there are no invasive plants within either site, the students will count the number of herbs along their transects. Why count the herbs? The majority of invasive plants in Alaska and across the globe are herbs. Many native herbs require the same conditions that invasive plants thrive in (high nutrient, high light conditions). Herbs, like invasive plants, tend to grow in higher abundances in areas of more recent disturbances. Therefore, if there are no invasive plants in an area, you could predict that the site with higher number of herbs would also be the better habitat for invasive plants.

There are many methods of describing the vegetation of a site. They range from large-scale descriptions that classify whole community types to

Table 12.1 Major plant growth forms in Alaskan habitats.

Plant Group	Structure	Example
Trees	One large woody stem	White spruce, aspen, Alaska birch
Shrubs	Many small woody stems	Willow, blueberry, alder, lowbush cranberry
Herbs	Smaller plants with no woody stem; grass-like plants and forbs (all other non-grassy herbs)	Fireweed, columbine, yarrow, horsetail, bluejoint grass, northern bog sedge
Non-Vascular Plants	No true stem; mosses and liverworts (Lichens are often lumped in this category, however, they are an algae and fungus…not a plant)	Feather moss, peat moss, green-tongue liverwort, reindeer lichen (not a plant!)

counting the numbers of individual species. Scientists use a variety of sampling methods to make describing plants easier. They can count the number of a particular species in many smaller portions of a site instead of counting every single plant in the whole area. They use averages and estimates to make their jobs a bit easier. Can you imagine trying to count all the plants in the whole forest!? A **transect** is one common method to sample vegetation. A transect is simply a line stretched through the vegetation in a random direction that helps scientists avoid only sampling in places that look interesting or in places that might bias their data. A **quadrat** is a square that is used for sampling. It further reduces the area in which the scientist has to count plants. Do not confuse the sampling tool quadrat with the word *quadrant*, which is the name of a section when an area is divided into four equal parts, or the name of an instrument used to measure altitudes. This lesson will use 50 cm x 50 cm quadrats every 5 meters along 20 m transects to count the number of invasive plants or herbs. Students in grades 4-6 will then calculate an average number of invasive plants along the transects. Students in grades 1-3 will calculate the total number of invasive plants along the transects. Figure 12.1 below illustrates thesampling methods to be used in this lesson. For more information on transect and quadrat sampling methods or other ecological sampling methods please refer to Smith and Smith 2001.

ADVANCED PREPARATION ✦

- Prepare students with an understanding of the major plant types (trees, shrubs, herbs, mosses/lichens) and scientific sampling using transects and quadrats.
- Predetermine a field study location where disturbed and undisturbed habitats occur relatively close together. Edges of burn scars or logging areas work well, as do roadsides adjacent to undisturbed forest areas.
- Assemble a 50 cm x 50 cm sampling quadrat by using four 50 cm lengths of PVC piping, or four 50 cm lengths of string.
- Gather materials and travel to the field site.

PROCEDURE ✦

1. **(Explore)** Observe the undisturbed and disturbed field sites. Have students observe silently for a few minutes. Discuss what they see. Are there trees, shrubs, or herbs? Are all the trees the same? Is there moss covering the ground, dead plants and leaves, or bare soil? What does the ground feel like? What does it smell like? Are there any signs of animals? Are there any plants present that are not native to Alaska?

2. **(Generalize)** Have students sketch what they see in the undisturbed and disturbed habitats. Remind them that

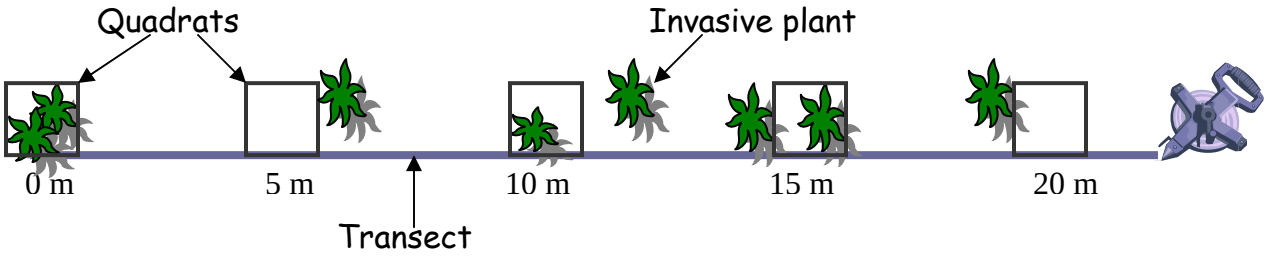


Figure 12.1 Transect sampling method to be used in this lesson.

they are drawing like a scientist. Can you draw a dinosaur in this picture? No! Draw only what you see.

3. **(Generalize)** For grades 3-6, have students answer the questions on the observation data table in their field study worksheet. Ask students to consider how the number of living trees, types of plants, type of ground cover, amount of light, and soil moisture might influence invasive plant growth. After making observations, have students return to the hypothesis section of their field study worksheet and predict which habitat would be more likely to have invasive plants present.

4. **(Inquiry)** Investigate if invasive plants grow better in the disturbed or undisturbed habitat. Conduct a plant survey along a 20 m transect in both the disturbed and the undisturbed habitats.
   - Lay a measuring tape out in a straight line. Every 5 meters have a small group set down a 50 cm x 50 cm quadrat, count the number of invasive plants in the quadrat, and record the number in their field notes. Why use a transect? First, it is difficult to count all the plants in a field site. Second, scientists use transects to pick sampling spots systematically, and to avoid only counting in places that look interesting or that might bias their data.
   - If there are no invasive plants in the disturbed or undisturbed field sites, have students count the number of native herbs in their quadrat. (Rule of thumb: if the plant has a woody stem, it is not an herb. Watch out for tree

Figure 12.2 First and fifth grade students observed an undisturbed forest near Fairbanks (A). They made a transect by stretching a tape measure 20 m through the forest (B). In a nearby site disturbed by wildfire, an adult helped a group of students count the number of herbs in a 50 cm x 50 cm quadrat (C).

and shrub seedlings.) Most invasive plants in Alaska are herbs. Have the students predict if invasive plants would grow better in a site with many herbs growing or with few herbs growing.

- For early primary classrooms have adults work with the small groups and count the number of invasives or herbs aloud.
- Don't forget to pull and dispose of any invasive plants that you see!

5. (Interpret) Back at school, debrief the field trip. **For grades 4-6,** important points to be discussed are their observations and data collected. This should be done as a prewriting activity before they start on their conclusion section of their field study worksheets. Use the conclusions on the field study worksheet to guide discussion. Have groups share what they discussed with the whole class.

For grades 1-3, draw pictures of the disturbed and undisturbed areas on an overhead projector as the students recall what they saw in each habitat. Have them compare and contrast the observations of the plants and soil of the two areas. Have kids sitting next to each other share their counts of herbs or invasive plants in the field study. They can do an informal check of each other's data sheets. This serves as a review and gear up for the graphing and conclusion of the field study. Making word boxes of important observations, data and conclusions as they share ideas will help prepare students for written conclusions.

6. Have students interpret their observations and data by answering questions in the conclusion section of their field study worksheets.

****Alternate method for counting plants using a transect:** Suspend a 10-20 m string over vegetation (20-30 cm off the ground) using one stake at either end. Divide the string into sections for any number of groups or students and mark the sections using tape or markers. Students count the number of invasives or herbs touching the string or directly below the string. Calculate the total number of invasives touching the transect, or the average number per section of the transect. (This method is adapted from Johnson et al. 1995.)

EVALUATION ✦

The completed field study worksheet serves as an evaluation for this lesson.

EXTENSIONS ✦

- Create a bar graph of the average number of invasive plants (or herbs) per 50 cm x 50 cm quadrat in the undisturbed and disturbed habitat. Before graphing data, review the purpose and the procedure of making a bar graph. Demonstrate how to make a bar graph of their data. Primary students can fill in the graph with class data as a guided lesson on the overhead. Intermediate students can make their own graphs.

- Compare the number of invasive plants in many different types of habitats. These could be different undisturbed habitats (deciduous forest, black spruce forest, coastal rainforest), different types of disturbances (logged area, burned area, roadside, trail system, abandoned agricultural field, recent construction site), or different stages of forest succession (herb stage, shrub

stage, young forest stage, old forest stage).

- Students can enter their field data into the Alaska statewide invasive plant database, which is known as the Alaska Exotic Plant Information Clearinghouse (AKEPIC), online at http://akweeds.uaa.alaska.edu/. By entering the species they found, the number of invasive plants, and the location of the infestation (a GPS point is requested, but not required), students can offer valuable data to land managers and scientists across the state.

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Hobbs, R.J., and L.F. Huenneke. 1992. Disturbance, diversity, and invasion: implications for conservation. *Conservation Biology* 6: 324-337.

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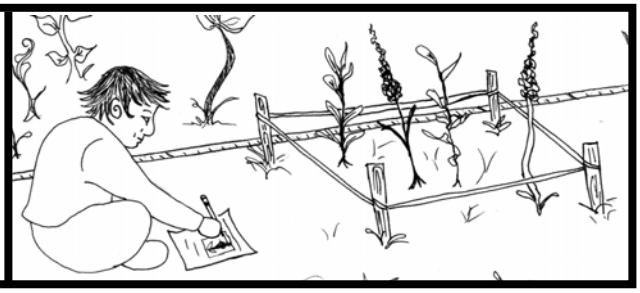
Invasive Plants and Disturbance Field Study

Name _____



Hypothesis: Where do you think invasive plants will grow better, in a disturbed area or in an undisturbed area? Why?

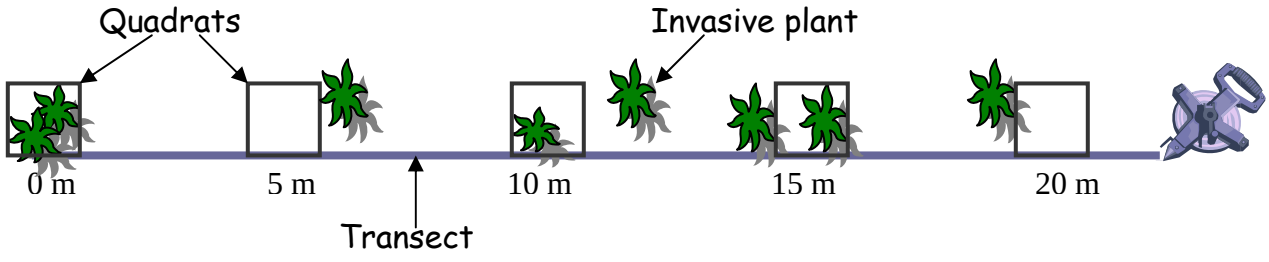
_____

_____

Procedure:

1. We will observe the plants, ground surface, and soil of an undisturbed and disturbed area. Look for signs of animals and take note of differences in the amount of light in each habitat.

2. We will count the number of invasive plants in quadrats every 5 meters along a transect in both the undisturbed and the disturbed areas. If there are no invasive plants, we will count the number of herbs.



Observations:

Draw what you see. Draw like a scientist.

Undisturbed Habitat	Disturbed Habitat

Describe the sites:

	Undisturbed Habitat	Disturbed Habitat
Are there living trees?		
What types of plants do you see? (Trees, shrubs, herbs, moss, seedlings)		
What covers the ground? (Green moss, Lichens, Soil, Leaves and Twigs, Rocks, Charcoal, etc.)		
Is the habitat open to light or shaded?		
Does the soil feel moist or dry?		

Results:

How many invasive plants did you count in your quadrat? _____

If there were no invasive plants, how many herbs did you count in your quadrat? _____

Class Data: Record the number of invasive plants (or herbs) your group and the other groups counted in the quadrats. Circle the quadrat that your group counted.

Quadrat Location along Transect	Number of Invasive Plants (or Herbs) in Quadrat	
	Undisturbed	Disturbed
0 m		
5 m		
10 m		
15 m		
20 m		

Calculate the average number of invasive plants (or herbs) in a quadrat for both the undisturbed and disturbed habitats. Record your answer here:

	Undisturbed Habitat	Disturbed Habitat
Average number of invasive plants (or herbs) per quadrat		

Conclusions:

1. How were the undisturbed and disturbed habitats different? How were they similar?

_____

_____

2. Did the undisturbed or the disturbed habitat have more invasive plants (or herbs if there were no invasive plants) growing in it? Circle one.

Undisturbed

Disturbed

3. Was your hypothesis correct? **YES** **NO**

4. Why do you think this happened? (Think about things that plants need to grow.)

_____

_____

_____

5. Do you think that an invasive plant would grow better in a habitat with lots of herbs or with few herbs? Why do you think so?

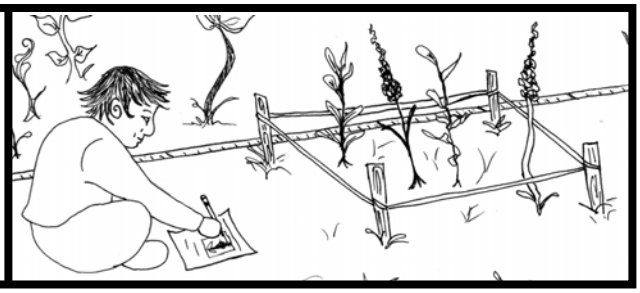
_____

_____

_____

Invasive Plants and Disturbance Field Study

Name _____

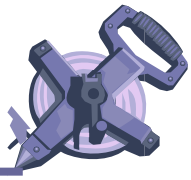


Observing an Undisturbed Habitat

Draw what you see.

Draw like a scientist.

How many invasive plants or herbs did you count?_____

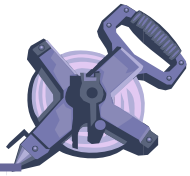


Observing a Disturbed Habitat

Draw what you see.

Draw like a scientist.

How many invasive plants or herbs did you count?_____



Making Conclusions: Do you think invasive plants grow better in undisturbed or disturbed habitats? Why do you think so?

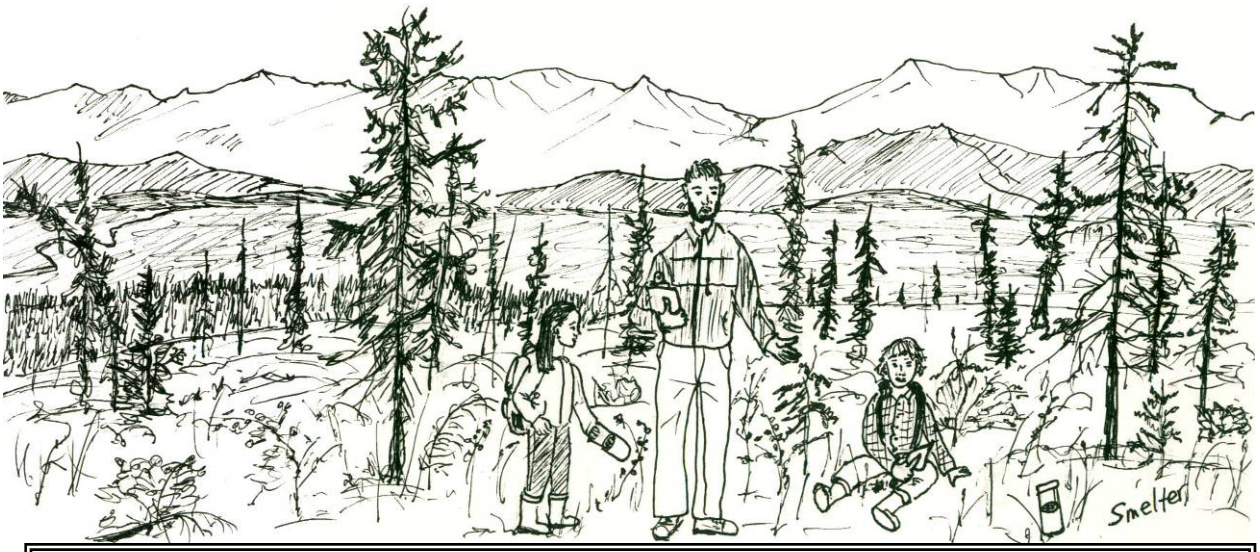
_____

_____

_____

Lesson 13

Invasive Plants and Disturbance Classroom Experiment



Grade Level: 1-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA2.1[3-6], SA3.1[3-6], SC1.1[3-5], SC2.1-2.2[3-6], SC3.1[3-6], SG2.1[3-6]
Subject: Science, Mathematics, Technology, Language Arts
Target Skills: observation, inference, prediction, communication, using space/time relationships, measurement, data collection
Duration: Four to eight weeks (One to two hours weekly)
Setting: Disturbance field site and classroom
Vocabulary: Disturbance, undisturbed, soil core, average, line graph, bar graph

INSTRUCTIONAL GOAL ✦

Students will investigate whether or not invasive plants grow best in areas of disturbance or in undisturbed areas and will draw conclusions from their results.

PERFORMANCE OBJECTIVES ✦

1. Students will conduct a long-term ecological research project on invasive plant growth in soil cores taken from disturbed and undisturbed habitats.

2. Students will make objective observations, measure and record plant growth, graph results, draw conclusions, and present their findings in experimental journals and project posters.

MATERIALS ✦

- Adult field trip chaperones
- Soil corer (bulb planter)
- Trowels

- Soil cores from disturbed/ undisturbed areas (one of each core type is needed for each student.)
- 10 invasive plant seeds per student (previously collected)
- Grow light equipment
- Leak-proof plant tray
- Planting pots
- Greenhouse rack to hold plant pots
- White poly-fill (available at any craft store) or rockwool (available at gardening stores)
- Craft sticks or white plastic plant labels
- Permanent markers
- Water spray bottle
- Experiment journals
- Colored pencils or crayons
- Centimeter rulers
- Over head projector, chart paper
- Computers (excel or other graphing program)

TEACHER BACKGROUND ✦

Disturbance plays a very important role in invasion processes. In this lesson, students will build on their observations from the previous lesson. This lesson is adapted from University of Alaska Fairbanks research by Katie Villano, Dr. Christa Mulder and Dr. Teresa Hollingsworth investigating the relationship between fire and invasive plants in Alaska.

Because the number of natural habitats that invasive plants have spread into is limited, scientists in Alaska must use an experimental approach to investigate the relationship between invasion and natural disturbance. We must use an experimental approach, if Alaskans want to predict where invasives will grow best before they get there. In this lesson, students will take part in gathering important data to help us be able to predict which habitats are most vulnerable to invasive plant colonization in Alaska.

Setting up a class experiment is a great way to continue the field study from the previous lesson, and to give students a chance to isolate some variables that could influence invasive plant establishment in the field. This experiment isolates differences in soil and ground cover vegetation. At the same time, the experimental approach eliminates variables such as light, water, canopy cover, and wildlife that might differ between disturbed and undisturbed sites.

This lesson's invasive plant study makes a wonderful science fair project. The data collected is important to share not only with the school community but with scientific community as well. Our understanding of the relationship between natural disturbance and non-native plant invasions in Alaska is currently very limited. Any data that your students collect on this topic is important for our efforts to prevent invasive plant spread in the state. Be sure to share your students' results with invasive plant researchers in your area (find Alaska invasive plant researchers at http://www.uaf.edu/ces/cnipm/docs/contactdirectory.pdf or in the list included at the end of this manual).

A long-term study on bird vetch invasion in the boreal forest was conducted by Denali Elementary School's first grade classes in Fairbanks, Alaska, during 2007-2008. It was shared with the school, the Interior Alaska Science Fair, UAF's Earth Day Fair, Creamer's Field Wildlife Refuge and with Alaskan scientists at a variety of conferences as a poster presentation.

Have fun exploring and experimenting!

ADVANCED PREPARATION ✦

- Make copies of the experiment journals for each student to record their data.

- Choose a field site to get the undisturbed/ disturbed soil cores. Use the same site investigated in the previous lesson. However, you can use any disturbed or undisturbed soils. Bring your trowels, soil corers, pots, permanent markers and plant labels.

- In the classroom, have the grow light equipment set up according to manufacturer's directions. You will need a leak-proof plant tray to put water in so the plants can be watered from the roots up. The *WEED WACKERS* materials kit includes pots, greenhouse racks, and plant trays.

- To prepare for collecting soil at the field site, stuff a wad of poly-fill (available at any craft store) or rockwool (available at gardening stores) in the bottom of the plant pots to cover the drain holes and prevent soil from escaping.

- Obtain seeds of an invasive plant species in Alaska. If you chose to use a legume species such as white sweetclover or bird vetch, you will need to scarify the seeds to prepare them for germination by gently rubbing them on sand paper. This will make tiny cracks in the seed coat. Scarification is necessary for many legume species to germinate, but the seeds of other Alaskan invasive plant species do not need to be scarified.

- Practice using the graphing program on the students' computers before the line-graphing portion of this lesson. For younger students, it would be great to recruit other adults to the classroom to help assist the students enter their data into the computers.

PROCEDURE ✦

1. **(Gear-Up)** Conduct activities in the two preceding lessons, "New Territory for Weeds" and "Invasives and Disturbance Field Study." The soil cores used in this lesson can be collected during the field trip in the "Invasives and Disturbance Field Study" lesson.

2. **(Explore)** At your field study site, demonstrate how to core soil samples

Figure 13.1 Students collect soil cores from a burn site and an undisturbed forest (left). In the classroom, an invasive plant was grown in the two different types of soil cores (right).

and then collect soil cores from disturbed and undisturbed study areas.

3. Use a trowel to partially fill the pot with 3-5 cm of mineral soil. Take the soil corer and use it like a cookie cutter to remove a 10 cm intact soil core. Place the core in the pot. Younger children may need assistance with the soil coring. Each student needs a sample from both areas.

4. Label each pot with the student name and the site (disturbed or undisturbed) on plastic plant labeling sticks or craft sticks using a permanent marker. One idea is to color code the names and samples (red for disturbed soil and green for undisturbed soil).

5. Back in the classroom, have students carefully examine each soil sample to observe the similarities and differences between them. Give time to explore what they notice about the soil and plants found in the disturbed and undisturbed soil cores. They can share their observations in science journals, discussions in small groups, or as a whole class.

6. **(Generalize) Making hypotheses and clarifying the question:**

   Do invasive plants grow better in a disturbed area or an undisturbed area? This is the students primary research question. Discuss with students whether they think invasive plants will grow better in the disturbed soil or undisturbed. Why? Tally up student hypotheses and record responses on chart paper or overhead projector for future reference. Older students can debate their reasons for choosing one hypothesis over another.

7. In the experiment journal included with this lesson, have students record their answers for hypothesis 1 and write a short rationale. For primary students, create a word bank on the chalkboard, chart paper, or overhead projector of specialize plant vocabulary that will help them write sentences in their experiment journals.

8. Offer the opportunity for early primary students to predict what their seeds will become. Have students draw an illustration of the seed and what they think it will become on the "Hypothesis 2" page of the experiment journal.

9. **(Inquiry) Setting up experiment:**
   - Get seeds of a plant invader. (Refer to lesson "On the Case: Investigating Alaska's Alien Invaders" for a list of possible species to collect seeds from.)
   - Put 5 seeds on top of the disturbed and undisturbed soil cores. Do not plant the seeds, but rather place them on top of the soil cores.
   - Place pots in a greenhouse rack and place the rack in a leak-proof greenhouse tray under a grow light.
   - Water the seeds. Water from the top by misting seeds twice a day during germination stage. Afterwards mist once a day. Water from the bottom by making sure the water tray is filled to the drainage holes during the course of the experiment.
   - Watch the plants grow!

10. **Making observations and collecting data:**
    - Once a week have the students observe what has happened in each of their samples. Discuss whether or not any seeds have sprouted. Have there been any changes to the plants that were already in their soil

cores? If the seeds have sprouted, what do the sprouts look like? How many leaves do they have? What shape and color are they? How many seeds have sprouted? Are the sprouts affecting any of the other plants in the core? How tall has your plant grown in a week?

- Using their experiment journals, primary students should draw what they see in the disturbed and undisturbed soil cores. Have students include all the native herbs and mosses in their pot as well as their invasive plants, trying to be as accurate as possible in color, plant shape, and plant characteristics. Intermediate students can record written observations as well.
- As the plants begin to sprout and develop have the students measure the tallest plant and record the height in their experiment journal.
- Conduct the experiment for 4-8 weeks, recording the observations and measurements at least once per week. To dispose of seedlings, ungerminated seeds, and soil at the conclusion of your experiment, carefully seal them in a plastic trash bag. Do not throw them outside or in compost.

11. Creating tables and graphs:

At the end of the experiment, have students compile their plant height data on the result chart included in the experiment journal. In primary grades, you might want the students to work in pairs, with one student reading the data for each date and the other student recording it on the results table. Intermediate students should be able to record their own data on their own charts.

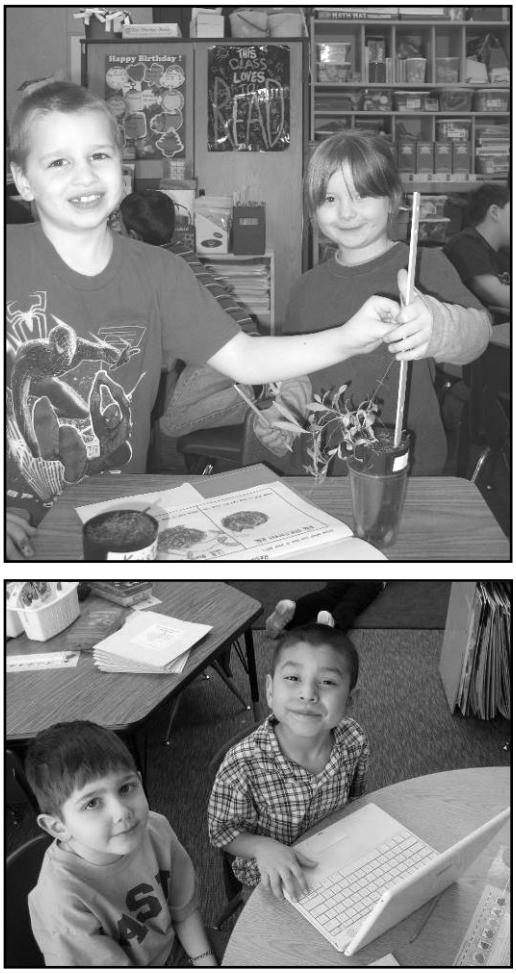


Figure 13.2 Students observe bird vetch growing in disturbed and undisturbed soil (top), then enter their data into a computer spreadsheet to make a line graph (bottom).

- Make a line graph of the invasive plant height data. This can be done using graph paper or on the computer using an excel spread sheet application. The observation date is on the x axis and the invasive plant heights in the disturbed and undisturbed soil cores is on the y axis. Color code the lines green for undisturbed and red for disturbed soil. Primary students once again work in pairs, with one student reading the data and the other student entering the data into the computer spreadsheet. Even first graders can be successful

in this process if adults are walking around making sure that they are on the correct cell on the spread sheet or box on the graph paper. The line graphs will show the data in a different way for the students and should provoke good questions, discussions and ideas about what happened in the experiment.

12. Compiling class data:

- Gather data from the final heights of plants in disturbed and undisturbed soil from all the students.
- Calculate the average final plant height for both types of soil and enter the averages in the class data table in the experiment journal. Primary students will have a hard time with this. Some options include using calculators for sums and averages (an important skill for primary students), a teacher directed computation lesson, or pre-lesson on averages (see the "Extension" section of this lesson for an optional lesson on teaching primary students about averages).
- From these averages, have students answer the questions under the data table in their experiment journals. Did individual students get the same results as the whole class?
- Make a bar graph comparing the average heights of the class' invasive plants in disturbed and undisturbed soils. Color code the graph: red bar for average plant height in the disturbed area and green bar for average plant height in undisturbed area. A blank bar graph is available for students to color in the experiment journal.

13. (Interpret) Making Conclusions:

- Discuss the bar graph with the class. Have students do share their results in pairs. The pairs should take turns discussing where the invasive plants grew best in the class experiment and why the seeds did better where they did (disturbed vs. undisturbed soil). This activity serves as a preliminary step to the writing conclusions in the experiment journal.
- After the pair shares ideas together, you might want to have the class mix up again to share with another partner to get another perspective if time permits. Partners come together and share with the whole class what their partners' conclusions. How did these conclusions compare to their original hypotheses recorded for hypothesis 1? Record ideas on chart paper, overhead projector, or on a word processor projected by LCM onto a screen. Discuss whether or not the results would be different if the seeds were growing outside in the different soil conditions. Have students record their ideas on the conclusion page in the experiment journal.
- Have the students look back at hypothesis 2 and determine if the invasive seeds grew into what they thought they would become. Press a sample invasive plant from one of their soil cores. Directions for pressing plants in included in the lesson "Native or Non-Native." After the pressed sample is dry, tape a pressed invasive sample into their experiment journal on the conclusion page for hypothesis 2. Have the students label the plant parts that make it a good invader. A word box is included for primary students.

- Allow students to make further inferences about their data. Ask students to imagine what would happen if the invasive plants keep spreading all around Alaska and there are more and more disturbances caused by fires, construction of roads and buildings, floods, permafrost disturbances, clear cut logging, storms, etc. Turn off the lights and turn on some new age or eerie music. Give the students a chance to make a mental image of the consequences of full blown invasion of alien plants in your area. With eyes open, have the class draw and write what could happen to Alaska's habitats if weeds (invasive plants) go wild. Include the drawing as the final page in the student experiment journal.

EVALUATION ✦

- The completed student experiment journal will serve as an evaluation tool.

- Students can present results to other classrooms in your school as a poster presentation. Be sure to include on the poster the question, hypotheses, materials used, procedure, results, conclusions and further questions. If your school and district have a science fair this could also be an opportunity for students to demonstrate knowledge gained and concepts learned. Older students can actually put together the information poster/science fair display themselves. This can be part of a hands-on process assessment. Primary students can also do oral presentations with direct guidance.

EXTENSIONS ✦

- One way to approach the concept of averages with primary children is to have them line up according to height. Have the students observe what height is basically in the middle of the height line. Compare averaging the class's invasive plant heights with your students' varying heights. You want to find the height that best represents all the heights in the class…not too tall, but not too small. Even though the younger students may not know how to compute the average this helps them better understand the process used to make the bar graph.

- Enter the class experiment in a school or district science fair.

- Share your results with local invasive plant scientists (www.uaf.edu/ces/cnipm/docs/contactdirectory.pdf or contact a scientist from the list at the end of this manual).

- Share your results with the community at local habitat conservation event.

REFERENCES ✦

Villano, K.L. 2008. Wildfire burn susceptibility to non-native plant colonization in black spruce forests of interior Alaska. Master's Thesis. University of Alaska Fairbanks, Fairbanks, Alaska.

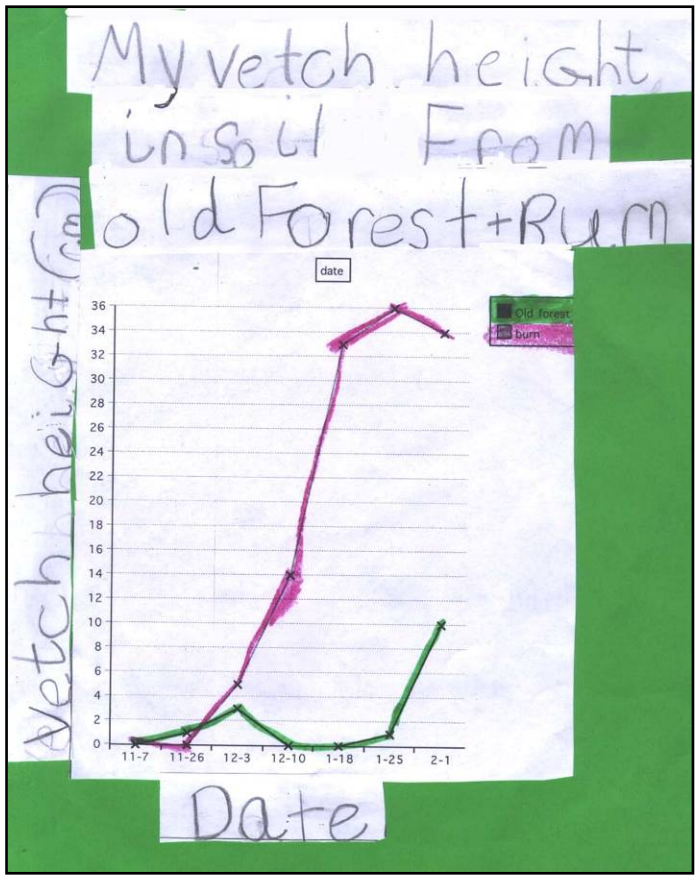
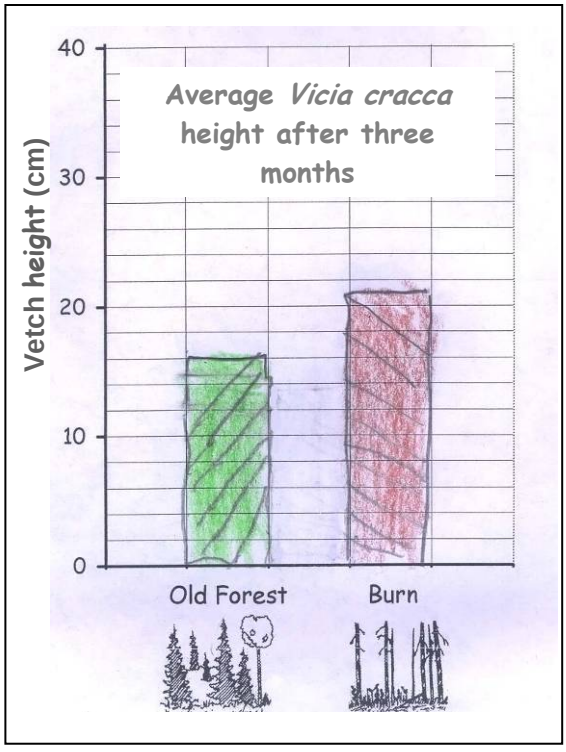
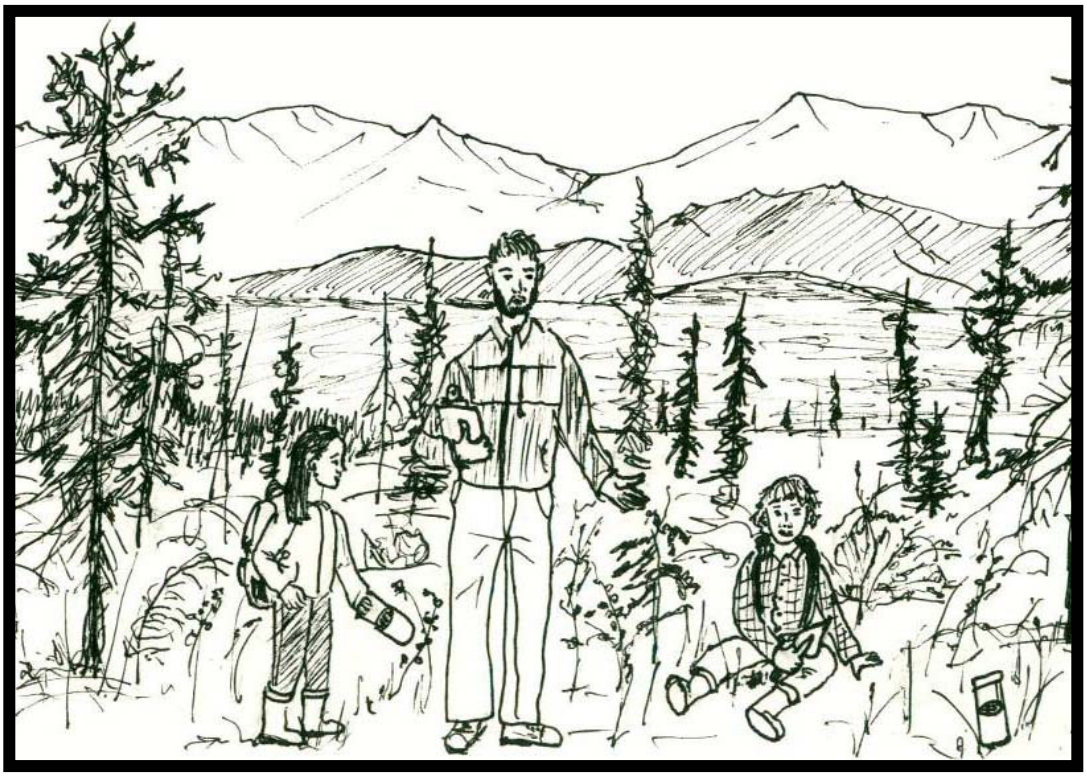


Figure 13.3 Examples of student graphs. The line graph (left) shows the change in height of the tallest invasive plant in a single student's soil cores through time. The bar graph (below) shows the average final height of the invasive plants in the soil cores of the whole class.



Plant Invaders and Fire

Experiment Journal



Name _____

Question:

Do plant invaders grow better in an old boreal forest or in a burn?

Hypothesis 1:

We took soil cores from an old forest and a burn. Circle the one you think will be a better place for plant invaders to grow.

Old Forest

Burn

Why do you think this? Write a sentence.

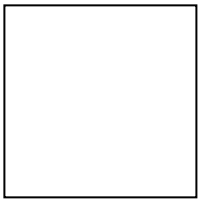
_____

_____

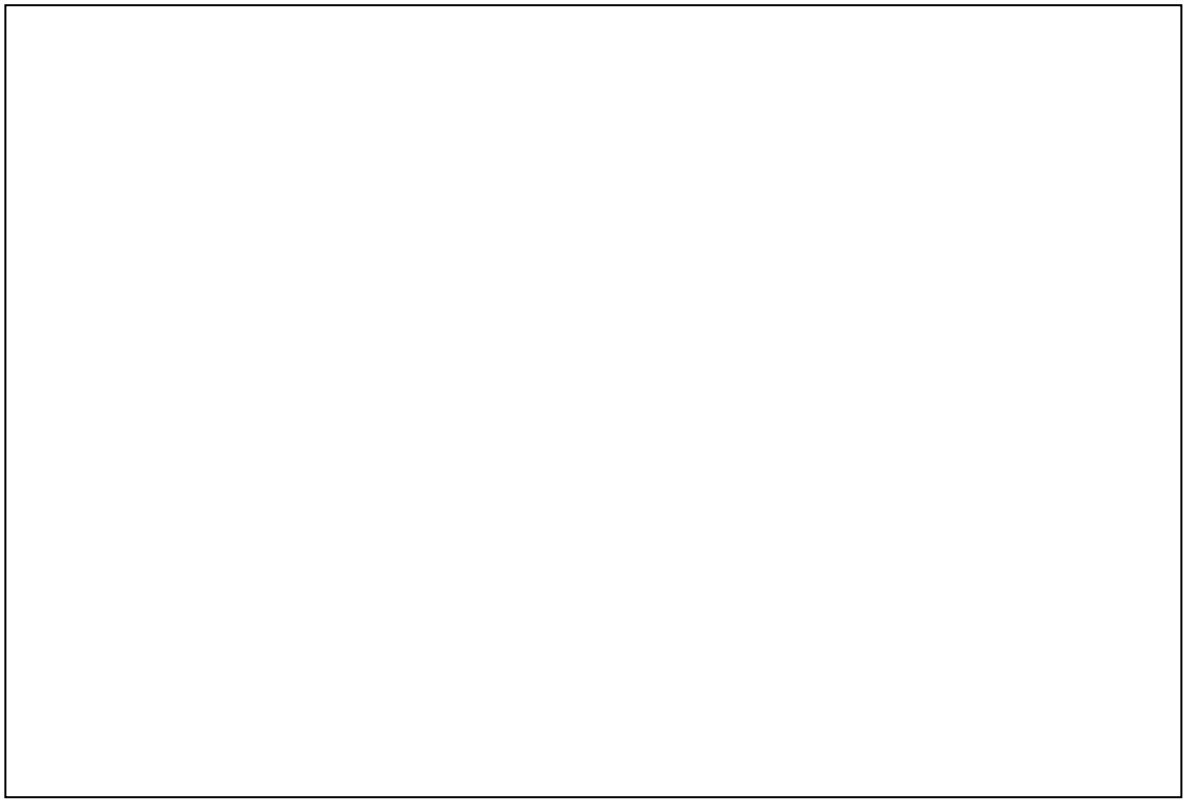
Hypothesis 2:

What do you think will happen to your seed?
Draw pictures.

This is my seed.



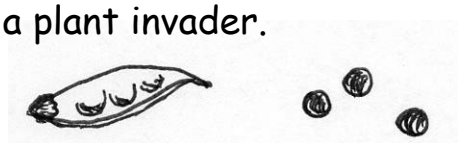
This is what I think it will become.



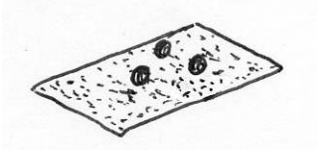
Procedure:

1. Get soil cores from a burned forest and an old forest.

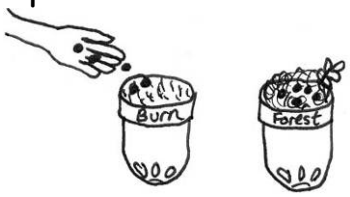
2. Get seeds of a plant invader.



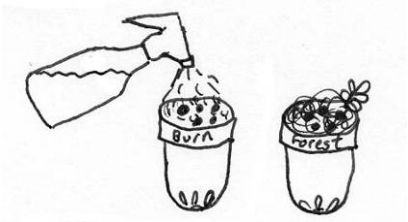
3. If you are using seeds from an invader in the pea family, take the seeds and make the seed coat rough with sand paper. If you are using invasive plant seeds from another family skip this step.



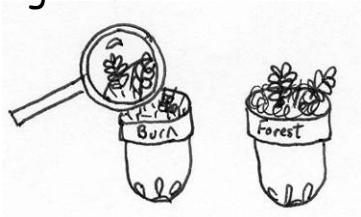
4. Put 5 seeds on top of the burned and old forest cores.



5. Water the seeds.



6. Watch the plants grow!



Results:

Draw what you see in your pots. **Date _____**

Old Forest

How tall is the invasive plant? _____ cm

Burn

How tall is the invasive plant? _____ cm

Results:

Make a chart with your data:

	Invasive Plant Heights	
Date	 Old Forest	 Burn

We will make a line graph on the computer with this data.

In which soil did your invasive plant grow **taller?** _____

In which soil did your invasive plant grow **faster?** _____

Results:

You will share the final height of your invasive plants with the whole class.

We will add up all the invasive plant heights for the old forest and the burn. Then, we will divide by the number of students in our class. The number we get will be an **average** plant height for the class.

Class Data:

	 Old Forest	 Burn
Average Invasive Plant Heights for the Class		

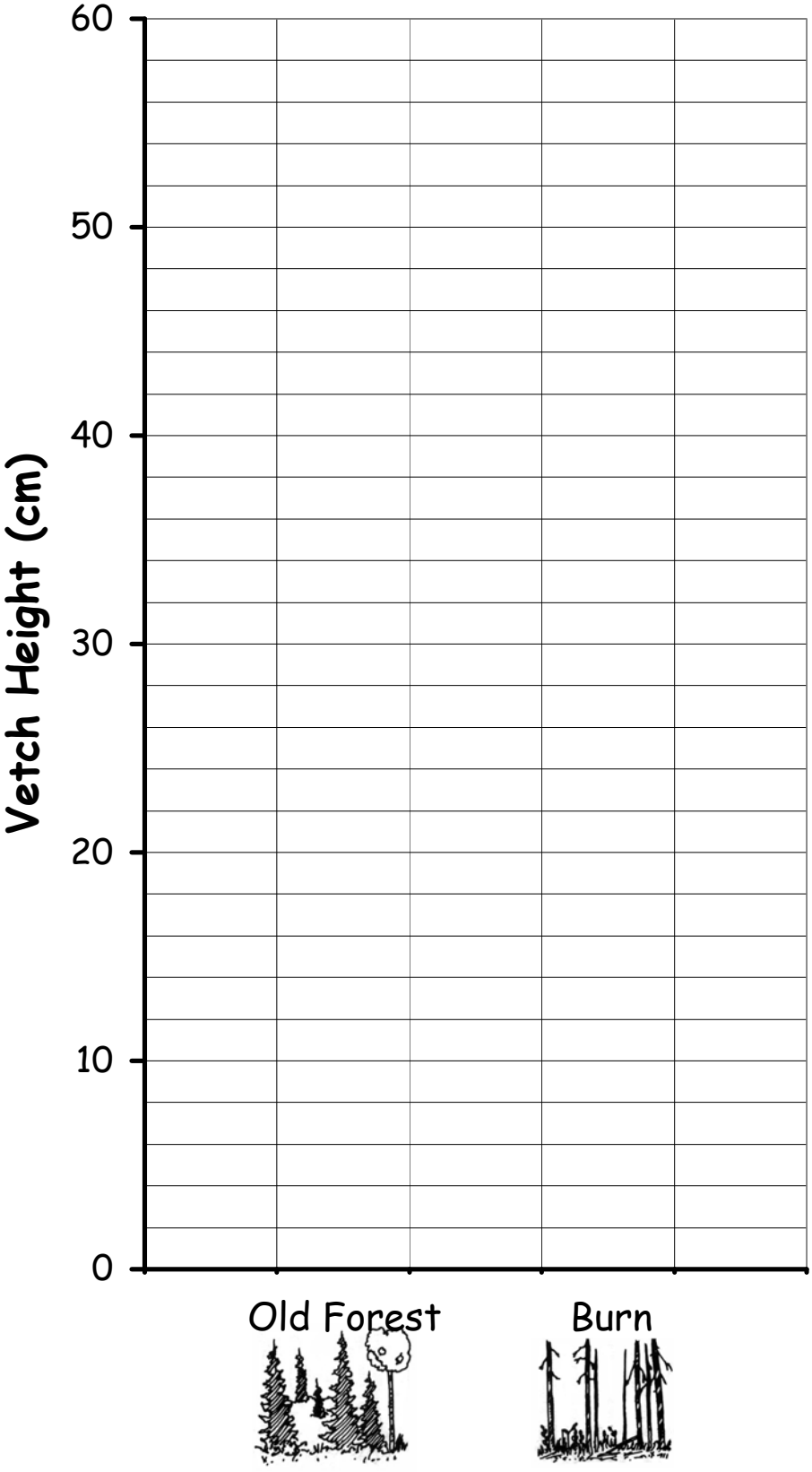
For the whole first grade, did the invasive plant grow taller in the old forest or the burn? _____

Did both classes get the same result? YES NO
Why do you think this happened?

_____

_____

Average heights for invasive plants grown in soil from an old forest and a burn.



Conclusions:

1. Our vetch grew better in the (Circle one)

Old Forest.

Burn.

2. Look back at your hypothesis 1. Was it correct? YES NO
   Were you surprised by what happened? Why?

_____

_____

3. Why do you think the vetch did better where it did?

_____

_____

4. Do you think the results would be different if the vetch was grown **outside** in an old forest and a burn? Why?

_____

_____

5. Look back at your **Hypothesis 2**. Did your vetch seed grow into what you thought it would become? **YES** **NO**

Here is my pressed vetch plant. Label the plant parts that help make it a good invader:

Word Box:	Leaves	Tendrils	Stem	Roots

6. What do you think would happen **if vetch keeps spreading** all around Alaska and there are **more and more fires** in Alaska, making **more and more burns**?

_____

_____

Draw a picture of what could happen to Alaska's forests:

Unit 3

Humans and Invasive Plants: What can Alaskans do?

In the final unit of *WEED WACKERS,* students will explore the relationships between human society, culture, and invasive plants in Alaska. As Alaskans, we depend on many non-native plant species, and often introduce them intentionally for agricultural or ornamental purposes. Not all non-native plants are able to live in Alaska without the help of humans. However, some non-native plant species can live on their own, or become naturalized, and some can become invasive and spread out of control. Human activity facilitates the spread of invasive plants throughout Alaska. Unlike any other state in the U.S., we are only at the beginning of the invasion process and still have many wild areas that have never been touched by a human, let alone an invasive plant. If we act quickly and continue to educate our communities, we can help prevent the continued invasion.

Lesson 14

Not All Non-Natives Invade

Grade Level: K-6
Alaska State Science Standards: SA1.1[3-6], SA2.1[3-6], SF1.1[3-6]
Subject: Science, Social Studies
Target Skills: communication, classification
Duration: 50 minutes
Setting: classroom
Vocabulary: transport, introduce, naturalized

INSTRUCTIONAL GOAL ✦

Students will understand that not all non-native species are invasive in Alaska, and that our lives depend on many non-native plant species.

PERFORMANCE OBJECTIVE ✦

Students will use a checklist to learn more about the origins of the plants they depend on for food, clothing, and medicine.

MATERIALS ✦

- Commonly used plant products from as many of the plants listed on table 14.1 as possible.
- "Where do these plants come from?" Activity Sheet (grades 3-6)
- Computers with internet access
- Post-it notes (one for each student; grades K-2)
- World map

TEACHER BACKGROUND ✦

Throughout history, as people have moved around the world, they have brought with them the plant species that they have depended on for food, clothing, shelter, and medicine. Today, with transportation so rapid and easy, it has become easier for plants to be moved from one place to the next. For the most part, the non-native species that people introduce to a new place remain under control. However,

some non-native species can become naturalized and live without the care of humans. Out of every 100 non-native species introductions, only about 10 will ever be able to survive outside of cultivation. Further, only one of those species will ever become invasive and dangerous to native habitats (Krasny et al. 2003). The goal of this lesson is to demonstrate that not all non-native species are problematic.

We depend on non-native plant species a great deal in Alaska. In the past, the native people of Alaska ate only native plants and animals. Today, nearly all the grains and vegetables we grow in our gardens or buy in grocery stores are from plants that are not native to Alaska.

This lesson was adapted from Mittermaier, B. 2005. "Global Marketplace." *Invaders of the Forest: Educators Guide to Invasive Plants of Wisconsin's Forest.* Wisconsin Environmental Education Board, Wisconsin Department of Natural Resources, and the Park People of Milwaukee County, Milwaukee, Wisconsin.

ADVANCED PREPARATION ✦

- Make a copy of the "Where do these plants come from?" activity sheet for each student.
- Assemble household food, clothing and medicines produced from as many of the plants listed in table 14.1 as possible.
- Write the names of the plants listed in table 1 on post-it notes.

PROCEDURE ✦

Grades 3-6

1. **(Gear-Up)** Examine a few common foods, clothing, and medicines from the table 14.1. Does anyone know what plants these objects are from? Did you realize that aspirin came from a willow shrub, or that chocolate came from the seeds of the cacao tree? Where did these plants come from? Are they native plants to Alaska? Willows grow all over Alaska and are native species. The cacao is a plant native to central and northern South America.

2. **(Explore)** Hand out the "Where do these plants come from?" activity sheet. Have students check off how often they think they use the plants on the list. Then have them guess if the plants are native to Alaska and the northern USA and Canada, or to some other region of the world. After students have completed the activity sheet, assign each student a plant to research on the internet. Students must discover where the plant was a native species.

3. **(Generalize)** Students present their findings to the class. All students correct their activity sheets as they learn the origin of each plant from their classmates. Were there any surprises? Did any of the plants the students use on a daily basis originate from places outside of Alaska or North America? Most of the plants we depend on everyday for food, fibers, and medicine are not native plants. Most non-native plant species are beneficial to us. Most of the plants we depend on could not survive outside of cultivation. They are not likely to escape and threaten Alaska's natural habitats. They are non-native, but not invasive.

Grades K-2

1. **(Gear-Up)** Examine as many of the plant products from the plants listed on

table 14.1 as possible. Does anyone know what plants these objects are from? Did you realize that aspirin came from a willow shrub, or that chocolate came from the seeds of the cacao tree? Where did these plants come from? Are they native plants to Alaska? Willows grow all over Alaska and are native species. The cacao is a plant native to central and northern South America.

2. **(Explore)** Hand each student a post-it note with the name of one of the plants listed in table 14.1. Have students come to the front of the class one at a time and show the plant name on the sticky note. Challenge the student to find a product made out of that plant from the items assembled. Read the origin of the plant to the class from table 14.1. Assist the student in affixing the post-it note to the plant's place of origin on the map.

3. **(Generalize)** After each student has affixed his or her post-it note to the map, count the number of plants that are native to our continent and to Alaska. How many were there from the list? How many were there from other places? Were you surprised that so many of the things you use everyday are made from plants that humans have transported all over the world? Explain that we depend on non-native plants in Alaska. Not all non-native plants spread out of control and harm Alaska's natural habitats.

EXTENSIONS ✦

- Ask students to search for plants native to Alaska or to North America at the grocery store. Can they find any? If the vegetable has an "Alaska Grown" sticker on it, does it mean the plant is a native plant?
- Create a menu using only plants that are native to Alaska. Include native wild berries, edible leaves, shoots, seeds, and roots. Read about Alaska's edible native plants in the book *Alaska's Wild Plants: A Guide to Alaska's Edible Harvest* by Janice Schofield.

REFERENCES ✦

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Mittermaier, B. 2005. "Global Marketplace." *Invaders of the Forest: Educators Guide to Invasive Plants of Wisconsin's Forest.* Wisconsin Environmental Education Board, Wisconsin Department of Natural Resources, and the Park People of Milwaukee County, Milwaukee, Wisconsin.

Schofield, J.J. 1993. *Alaska's Wild Plants: A Guide to Alaska's Edible Harvest.* Alaska Northwest Books, Anchorage, AK.

Table 14.1 Origins of common plants that Alaskans use to make food, clothing or medicine. Information from this table was adapted from Mittermaier (2005).

Plant	Use	Region of Origin
apple	food	southeast Europe, western Asia
aloe vera	medicine (aloe gel in lotions and cosmetics)	Africa
birch	food (source of birch syrup)	northern United States (including Alaska!), Canada
black pepper	food	India, Asia
blueberry	food	northern United States (including Alaska!), Canada
cacao	food (source of chocolate)	Central America, Northern South America
carrot	food	northwest India, Afghanistan
cinnamon	food	Sri Lanka
corn	food	southern Mexico, Guatemala
cotton	clothing	Central America, India
cranberry	food	northern United States (including Alaska!), Canada
ephedra	medicine (source of ephedrine in nasal decongestants)	Asia
flax	clothing (source of linen)	Europe
lettuce	food	Turkey, Iran, Turkistan
oats	food	eastern Mediterranean, Eurasia
onion	food	northwest India, Afghanistan, northern and central china
peas	food	Mediterranean, northwest India, Afghanistan
potato	food	Peru, Ecuador, Bolivia, Chile
pumpkin	food	Peru, Ecuador, Bolivia
rice	food	southeast Asia
strawberry	food	northern United States (including Alaska!), Canada
tomato	food	Peru, Ecuador, Bolivia
watermelon	food	south central Africa
wheat	food	eastern Mediterranean, Eurasia
wild rice	food	northern United States, Canada
willow	medicine (source of aspirin)	circumpolar north (including Alaska!)

Name_____

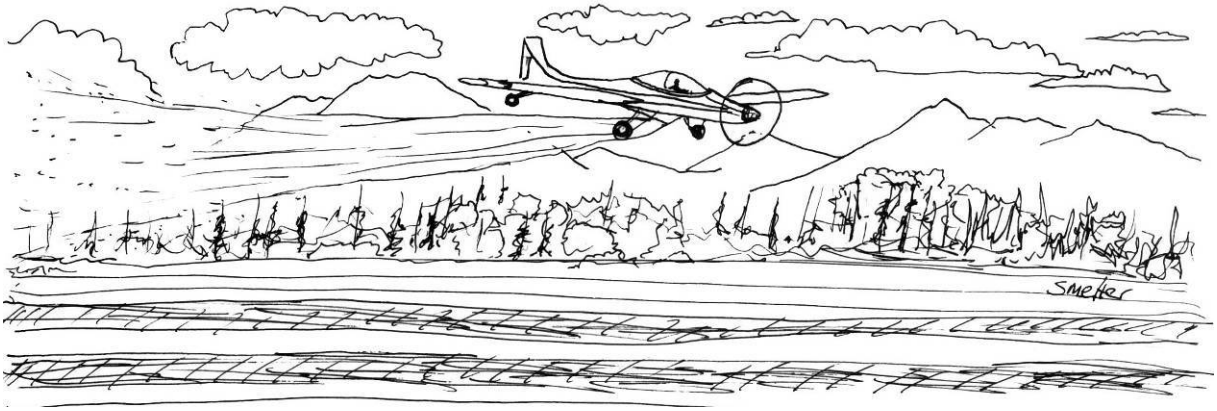
Where do these plants come from?

How much do you know about the plants you depend on?					
Plant Name	How often do you use this plant?			Where is this plant originally from?	
	Often	Sometimes	Rarely or Never	Northern USA, Alaska, and Canada	Some other region
apple					
aloe vera					
birch					
black pepper					
blueberry					
cacao					
carrot					
cinnamon					
corn					
cotton					
cranberry					
ephedra					
flax					
lettuce					
oats					
onion					
peas					
potato					
pumpkin					
rice					
strawberry					
tomato					
watermelon					
wheat					
wild rice					
willow					

(Adapted from Mittermaier 2005)

Lesson 15

Invasive Plant Management: A Race Against Time



Grade Level: 1-6
Alaska State Science Standards: SC3.1[3-6], SE1.1[3-6], SE2.1[3-6], SE3.1[3-6], SF1.1[3-6]
Subject: Science, Social Studies
Target Skills: Communication, classification, using space/time relationships, inference
Duration: 60 minutes
Setting: Classroom, and open space such as playground or gym
Vocabulary: Mechanical control, chemical control, biological control, prevention, education, herbicides, adaptive management, Early Detection Rapid Response (EDRR), Integrated Pest Management (IPM)

INSTRUCTIONAL GOAL ✦

Students will learn different methods to control invasive plants currently used in Alaska: manual control (by hand pulling), mechanical control (by mowing), chemical control (by spraying herbicides), and prevention of new introductions (through public education).

PERFORMANCE OBJECTIVES ✦

1. Students will discover different approaches to invasive plant control by watching a photo slideshow of control efforts in Alaska.
2. Students will apply their understanding of these methods in a problem-solving game.

MATERIALS ✦

- "**Fighting Invasive Weeds in Alaska**" slideshow on WEED WACKERS companion CD
- Game cards
- Invasive plant management story problems

TEACHER BACKGROUND ✦

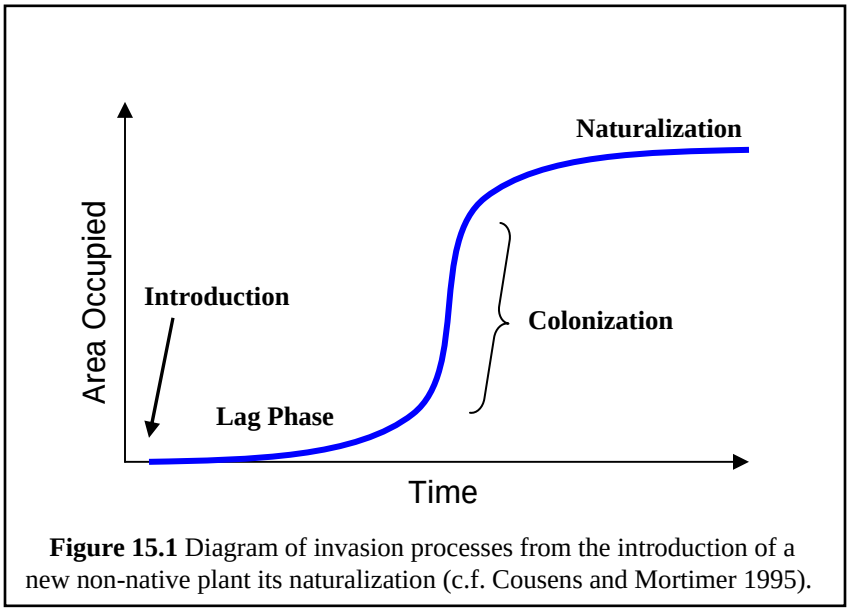


Figure 15.1 Diagram of invasion processes from the introduction of a new non-native plant its naturalization (c.f. Cousens and Mortimer 1995).

Despite the fact that most introduced plants in Alaska do not invade our natural habitats, the species that are invasive or have been invasive in other places in the U.S. or Canada are extremely important to prevent from spreading throughout the state. After a successful introduction, populations of invasive plants tend to spread slowly at first. Figure 15.1 illustrates this as the "lag phase" of the invasion process. Human communities tend not to notice the slowly increasing populations during the lag phase.

Once they become established, invasive plants can rapidly colonize and spread exponentially (Figure 15.1). For example, during the 1980s and 90s in Fairbanks, bird vetch (*Vicia cracca*) didn't appear to be spreading. Few people were concerned about the species, and people even transplanted it to their yards and gardens as a wildflower. Over the past five years, however, the bird vetch has exploded throughout Fairbanks, is now seen on nearly every roadside, and is spreading into urban forests, parks, and wildlife preserves. Eventually, an invasive plant population will grow until it reaches the carrying capacity of the environment and has taken all the resources from the habitat that it is capable of taking. This is the naturalization phase of the invasion process illustrated in figure 15.1.

In Alaska, most invasive plant populations are still in the lag phase or early colonization phase of the invasion process. Many dangerous species that occur in the lower 48 states, such as yellow star thistle and leafy spurge, have not yet been introduced here. To prevent the exponential spread of invasive plants in Alaska, we must take action now. We can hold existing invasive populations at bay using a variety of invasive plant control techniques, or prevent new introductions through education, and **early detection and rapid response (EDRR)** of new species.

Types of invasive plant control:

1. **Manual Control:** By hand pulling or digging, invasive plants can be manually controlled. Manual control is the most effective when the population of invasive plants is small. Typically, manual control must be done more than once. After a weed pull, invasive seeds or living roots and stems may still be present in the soil. Hand pulling is still an effective technique for most invasive plant populations in Alaska, as most are still small, isolated patches

that can be taken care of with early detection and rapid response. This lesson refers to manual control as "**Pull**."

2. **Mechanical Control:** Using machines to help cut or damage invasive plants, mechanical control is a good approach for large populations of invasive plants where hand pulling seems impossible. Using mechanical approaches, however, it is harder to ensure that you won't damage the native or desired plants, than it is with hand pulling. This lesson refers to mechanical control as "**Mow**."

3. **Chemical Control:** Chemical control uses herbicides to kill invasive plants. The herbicides used to control invasive plants are carefully researched, and are only used if they are known to be safe for people and the environment. Herbicides are often used as a last resort, when other attempts have failed, and the cost of allowing the invasives to spread outweighs the cost of herbicide application. For many land managers, whether to apply herbicides is an ethical decision that is not taken lightly (Tu et al. 2001). Herbicides should only be applied by certified experts, and to get this point across to elementary students we refer to chemical control in this lesson as "**Call and Spray**".

4. **Biological Control:** Biological control (biocontrol for short) is the use of animals, fungi, or other microbes to feed upon a target invasive plant. It is often used as an alternative to chemical control and when large invasive plant populations are beyond the hope of controlling manually or mechanically. Biocontrol requires in-depth knowledge of the food webs in the region of the infestation, as well as in the invasive plant's region of origin. Years of research must go into investigating the potential consequences of introducing a new grazer or insect into a system. Biocontrol is not used as often in natural ecosystems as it is in agricultural systems. At this point, biocontrol is not used in Alaska, and it will not be discussed in the activities in this lesson.

5. **Prevention:** We can control invasive plants by preventing their initial introductions. Strict regulations on the import of invasive species can help prevent new introductions. In addition, one of the most effective ways to prevent the spread of invasive plants is to create an informed and concerned community of Alaskans. Thank you for helping accomplish this goal right now! We refer to prevention in this lesson as "**Educate**."

There is no silver bullet solution for controlling invasive plants. Often mechanical control will be used, and then chemical control will be used months later to kill off any re-sprouts. A mixed approach to invasive plant control may be Alaska's best hope for controlling the populations of invasive plant species that are in the later stages of colonization. For example, white sweetclover (*Melilotus officianalis)* is widespread along highways that border some natural disturbance areas in Alaska. **Adaptive management**, or continuous re-evaluation of management approaches and restoration goals, is the best approach to controlling invasive plant species (Tu et al. 2001). When applied to the management of invasive plant species, adapted management is specifically

referred to as **integrated pest management (IPM).**

In this lesson, students will learn about the different invasive plant control techniques used in Alaska, and apply their understanding of these techniques in a problem-solving game.

ADVANCED PREPARATION ✦

- Prepare projector for power point presentation.
- Make enough copies of game cards for each student to have a set.

PROCEDURE ✦

1.(Gear-Up) Show the "**Fighting Invasive Weeds in Alaska"** slideshow of different approaches to invasive plant management occurring in the state. The slideshow by Dr. Steve Seefeldt, United States Department of Agriculture—Agricultural Research Service, is included on the *WEED WACKERS* guide companion CD. Information on each slide is listed here:

Slide 1: How can we fight the spread of invasive plants in Alaska?

Slide 2: Invasive plants, like the white sweetclover here, present a threat to Alaska because they can spread and multiply very quickly. White sweetclover lives for two years, and a single plant can produce up to 350,000 seeds in its life cycle. In this picture you can see the gray stalks that remain from last year's two-year old plants. This year, there are thousands of new sweetclover seedlings. Because invasive weeds can spread so quickly, we must act fast to control them.

Slide 3: The scientists at the USDA-Agricultural Research program in Alaska have been studying how to fight invasive plants in Alaska. They have been focusing on fighting three species of weeds that are a big problem for Alaska. One is orange hawkweed. Orange hawkweed can spread quickly by seeds or spreading stems called stolons. It has taken over many areas in the Southern part of Alaska.

Slide 4: White sweetclover is one of the most abundant invasive plants in Alaska. It has been spreading out of control along some rivers in Alaska. The seeds can move from the roadside near bridges into rivers and float until it lands on a nice sandy shore to grow. If we can fight sweetclover near bridges, we can stop it from spreading down rivers.

Slide 5: Bird vetch has spread quickly near towns in Alaska. It can climb up native plants and steal light from them. It can spread quickly by using underground stems called rhizomes, and by shooting seeds from its pea-like pods.

Slide 6: One way to fight weeds is by pulling them up with your hands. These scientists wanted to know if pulling weeds by hand was enough to control the plants. It takes a lot of people to pull invasive weeds.

Slide 7: The people in this picture are pulling orange hawkweed at an airport. See the airplane? The orange hawkweed seeds could get spread to remote areas of the state by accidentally being transported in airplanes.

Slide 8: You must pull orange hawkweed very carefully. A whole new plant can grow out of tiny pieces of the roots if they are left in the soil.

Slide 9: Look at what a difference they made by pulling the orange hawkweed! Can you see the scientist's study plot? The four corners are the white flags, and the center of the plot is the yellow flag.

Slide 10: Sometimes there are too many weeds to fight. If there is a whole field of invasive plants, pulling them would take too long and require a whole army of people. In these cases, mowing the invasive plants to prevent them from making seeds is a good approach.

Slide 11: White sweetclover that grows densely on the sides of roads, can be controlled by mowing the side of the road.

Slide 12: Look how big the blade of the mower is!

Slide 13: Mowing made a difference! Can you see where the mowing controlled the plants? The plants look brown compared to the stripes of plants that didn't get mowed.

Slide 14: Sometimes neither mowing nor hand pulling kill the invasive weeds. Some weeds just keep coming back. One way that scientists use to kill dangerous invasive plants is to poison them. These poisons are called herbicides. They work by disabling enzymes that only certain plants have, that way they do not harm animals and people.

Slide 15: Spraying herbicides is a last resort for controlling weeds. Experts spray weeds sometimes when there is a great economic or ecological cost if the invasive plants remain, and when no other approach has worked after several years. Kids should never use herbicides. Only a trained expert like the one in this picture should spray herbicides.

Slide 16: By pulling, mowing or calling an expert to spray invasive plants, we can help solve problems that invasive plants could cause in Alaska. Bird vetch, here on the hill outside of the University of Alaska Fairbanks Museum of the North, could cause problems in natural habitats.

Slide 17: Can you find the bird vetch growing among the native Alaskan plants?

Slide 18: Bird vetch could climb over and out-compete the native plants in this burn area in interior Alaska. It could also change the soil in burn areas. But, by pulling, mowing, or spraying bird vetch, we can prevent it from getting far into the burn.

Slide 19: We can fight the spread of invasive weeds in Alaska!

Figure 15.2 Mowing invasive weeds is a good approach for preventing their spread along roadsides. Photo courtesy of Steve Seefeldt, USDA ARS, 2008.

2. **(Explore)** Students have the opportunity to ask questions about the photos or pose possible scenarios where you might need to use different approaches to control and manage the invasive plants.

3. **(Gear-Up)** Sing the song "Pull, Mow, Call and Spray" and act out the motions of each approach to invasive plant control.

"Pull, Mow, Call and Spray"
(To the tune of "Head, Shoulders, Knees and Toes")
By Christine and Katie Villano

Pull, Mow, Call and Spray, schhhh schhhh!
Pull, Mow, Call and Spray, schhhh schhhh!
Pull, Mow, Call and Spray,
to make invasives go away! Go away!

Song Actions:
Pull- Grab imaginary weeds at your feet.
Mow- motion as if pushing a lawn mower.
Call- hand to head like a telephone receiver.
Spray- both hands up with fingers pressing the top of an imaginary spray bottle twice in rhythm with the spray sound effects "schhhh schhhh."
Go Away- thumbs pointing over your shoulders.

4. **(Generalize / Interpret)** Take students to an open area to play the game "Invasive Plant Management: A Race Against Time." Explain that controlling the spread of invasive plants in Alaska is like a race. It is us against the invaders. Right now we have the chance to prevent them if we use effective prevention and control approaches. Invasives spread very quickly, so we must act fast.

Game Procedure:

- Students line up holding 4 game cards: Pull, Mow, Spray, and Educate (figure 15.3A)
- The game leader stands 10-15 meters from the line of students and reads a story problem aloud to the group. Students decide which approach would be the best in the situation presented (figure 15.3B).
- Students hold up the appropriate card to answer the story problem. If the student is correct, they advance one giant step (like in the game "Mother May I") (figure 15.3C).
- The first student to arrive at the game leader is the winner and has successfully protected Alaska from invasive plants.

EVALUATION ✦

Observe students during the game to assess student understanding.

EXTENSIONS ✦

- Establish small study plots in your schoolyard to experiment with different invasive plant control methods. Have students choose a control technique with the goal of killing the non-native plants while allowing the native plants to thrive. Groups can choose to hand pull their weeds, simulate mowing by cutting all the plants in their plot with scissors, or spray their plants using a diluted vinegar solution. After a week, which method had the least weeds

growing back? Did different methods work better for different invasive weed species?

- Invite a local cooperative extension agent, Cooperative Weed Management Area (CWMA) representative, US Department of Agriculture researcher, or other invasive plant control expert in your area to talk to students about their efforts in Alaska. Need help finding an expert guest speaker? Visit the Committee for Noxious and Invasive Plant Management website for a contact directory (http://www.uaf.edu /ces/cnipm/contactdirectory.html).

- Organize a weed pull with your students to help your local community control problem invasive plants.

REFERENCES ✦

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Tu, M., C. Hurd, and J.M. Randall. 2001. Weed Control Methods Handbook, April 2001 version, The Nature Conservancy. Available: tncweeds.ucdavis.edu

Figure 15.3 Students play the invasive plant control problem solving game "Invasive Plant Management: A Race Against Time," described in this lesson. Photos by Erin Carr, USDA ARS, 2008.

Invasive Plant Control: A Race Against Time

Game Story Problems

1. Some students go outside to play on the playground and see the yellow-flowered butter and eggs growing along the fence. What should they do?

Answer: PULL (There is only a small amount of weeds. Pull by hand.)

2. On a field trip to a local wildlife preserve, you see a small patch of Canada thistle growing along a trail. What should you do?

Answer: PULL (There is only a small amount of weeds. Pull by hand.)

3. You are at a greenhouse buying plants with your mom for your garden. You walk down an isle and see a suspiciously familiar looking plant. Luckily, you happen to have your "Selected Invasive Plants of Alaska" pocket guide with you. You look in the guide, and sure enough, the plant for sale is the invasive leafy spurge. What should you do?

Answer: EDUCATE (Leafy spurge has not yet been found spreading in Alaska. Show the store manager your pocket guide. Maybe they will help prevent leafy spurge from spreading in Alaska.)

4. In the forest by your house your family has pulled up the invasive plants for two years but they grew back. What should you do?

Answer: PULL (The patch of invasive plants is small, and the seeds of the plants are probably still in the soil. Keep pulling the plants to deplete the seeds bank.)

5. All the university hills are covered with purple vetch plants that look so pretty. What is the first step to get rid of them?

Answer: MOW (The amount of invasive plants is too great for hand pulling to be effective. Try mowing to prevent more seeds from being produced)

6. All along the highway between Fairbanks and Anchorage there are many invasive plants growing. What is the best way to get rid of them?

Answer: MOW (The amount of invasive plants is too great for hand pulling to be effective. Try mowing to prevent more seeds from being produced)

7. Farmers in Delta Junction are trying to grow large fields of wheat to use for cereal and bread. They try to keep invasive plants from their farms. They cannot mow the invaders because they will mow down the wheat plants too. How can they get rid of acres of invasive plants mixed in with their wheat?

Answer: SPRAY (The amount of invasive plants is too great for hand pulling to be effective. They can't mow or they'll ruin their crop. They can spray an herbicide that targets only broadleaf plants. The weeds will die, but the wheat will not be harmed.)

8. Walking along a forest trail in Juneau you spot some garlic mustard growing among the Alaskan plants. You learned that garlic mustard can quickly take over the whole forest floor. What should you do?

Answer: PULL (There is only a small amount of weeds. Pull by hand. Immediate response is necessary to prevent the garlic mustard from spreading.)

9. There are invasive plants growing in your yard near your mailbox. What should you do first?

Answer: PULL (There is only a small amount of weeds. Pull by hand.)

10. Last year big backhoes and trucks dug up a few miles of highway to fix it. Along the same stretch of road this year, there are several types of invasive plants now growing. What could we do?

Answer: MOW (The amount of invasive plants is too great for hand pulling to be effective. Try mowing to prevent more seeds from being produced)

11. A scientist is doing field work on the tundra and sees that an invasive plant is growing along the gravel road for miles. What should she tell land managers to do to prevent the weeds from spreading?

Answer: MOW (The amount of invasive plants is too great for hand pulling to be effective. Try mowing to prevent more seeds from being produced)

12. Creamer's Field in Fairbanks burned part of its field of grass last year. Now there are thousands of bird vetch plants growing. What should they do?

Answer: MOW (The amount of invasive plants is too great for hand pulling to be effective. Try mowing to prevent more seeds from being produced)

13. The gardeners at a public park want to plant European bird cherry trees to attract birds in fall and winter and display their sweet smelling blossoms in spring. You know that bird cherry trees have started to become invasive in some parts of Alaska. You think they could use a non-invasive alternative to bird cherry trees. What should you do?

Answer: EDUCATE (Explain to the park gardeners that bird cherry has started to spread along salmon streams in Anchorage, and has been spread by birds into the forest at Creamer's Wildlife Refuge in Fairbanks. Urge them to help reduce the spread of this plant by using a flowering tree species that does not spread in Alaska's natural habitats.)

14. Your grandma was shocked to see orange hawkweed growing in her vegetable garden. She thinks it looks so beautiful, so maybe she'll let it grow alongside her carrots. What should you tell her?

Answer: PULL (There is only a small amount of weeds. Pull by hand.)

15. Aunt Minnie loves purple wildflowers and plants seeds in her garden from different purple-flowered plants. One of the flowers is purple loosestrife. The purple loosestrife grows and takes over her garden. She thinks she can keep it just within her wildflower garden. What should we tell her to do?

Answer: PULL (There is only a small amount of weeds. Pull by hand. Immediate response is necessary to prevent purple loosestrife from spreading.)

16. Debbie sees bird vetch growing on the sides of hills year after year near Ester. She has vetch pulling parties with friends for the past 6 years. Last year her friends mowed and pulled for days but it all grew back. What should happen next?

Answer: SPRAY (The seeds of bird vetch can generally last in the soil for 5 years. If Debbie and her friends never let the bird vetch go to seed, then hand pulling doesn't seem to be working. To get rid of the bird vetch once and for all, she should call an expert to spray the weeds.)

17. The teachers club is thinking about selling a wildflower seed mix to raise money for field trips. The teachers think the seed mix will be a big hit and they'll make lots of money if the sale is successful. A student scientist in the first grade notices that the wildflower mix includes a plant called oxeye daisy. The first grader knows that this plant is not from Alaska and can harm habitats. What should the first grader do?

Answer: EDUCATE (The student can help prevent the teacher's club from accidentally spreading an invasive plant by giving them information on the impacts oxeye daisy can have on natural habitats. Suggest to the club that they sell a wildflower mix of native Alaskan wildflower seeds.)

Invasive Plant Control: A Race Against Time
GAME CARDS

PULL

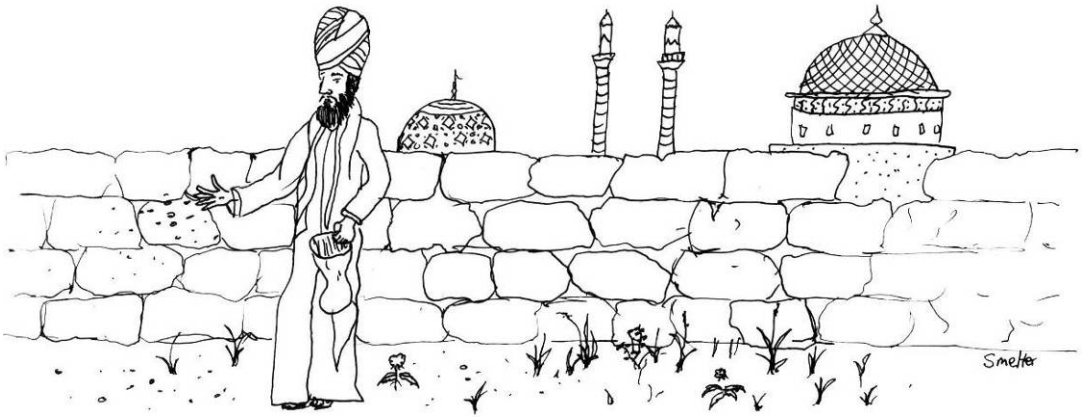
SPRAY

MOW

EDUCATE

Lesson 16

"Love the Weeds"
Invasive Plants and Human Values



Grade Level: 5-6
Alaska State Science Standards: SA2.1[3-6], SF1.1[3-6], SF2.1[3-6], SF3.1[3-6]
Subject: Social Studies, Language Arts, Science
Target Skills: Communication
Duration: two 30 minute sessions
Setting: Classroom
Vocabulary: biodiversity, invasive plant management, human values

INSTRUCTIONAL GOAL ✦

Students will understand that the choice to manage and control invasive plant species in Alaska is based on human value systems.

PERFORMANCE OBJECTIVES ✦

1. Students will choose sides on the invasive species debate by taking a survey of their values.
2. Students will discuss the role of human values in developing people's perspectives on invasive plants.

MATERIALS ✦

- "Invasive Weed Values Survey"
- Fairbanks Daily News-Miner articles:

  "Backyard wilderness, whether seed or foreign weed, still brings joy," by Theresa Bakker, July 13, 2008

  "Controlling the spread of invasive plants," by Diane Claassen, July 14, 2008

TEACHER BACKGROUND ✦

Are invasive plants good or bad? This is a tricky question and the answer depends solely on your perspective and what you value. Farmers and the people fed by agricultural products value crops. From their perspective, invasive weeds are bad because they reduce crop yields and cost time and money to eradicate. In the past, people who were trying to re-vegetate a site after construction or mining projects needed quickly growing and spreading plants to protect the soil from erosion and to prevent streams from getting clogged with sediment or contaminated with construction byproducts. From their perspective, invasive weeds were good, and perfect for the job.

The changes in human value systems have played an important role in the way we think about invasive plants. In the late 1880s, people began to recognize the need to conserve wild places in the United States. In the1960's people began to recognize biodiversity, or the variation and distribution of life forms in an ecosystem, as an important thing for them to value. In 1966, the United States Government put conservation of biological diversity into law in the first Endangered Species Act (ESA 1966). Biodiversity is important for ecosystems to remain stable (Loreau et al. 2002), and is important for people who depend on the ecosystem services that their habitats provide (such as subsistence food harvests, building materials, medicinal herbs, aesthetic and spiritual properties, nutrient cycling to maintain fertile soils, temperature regulation, air and water quality maintenance) (MEA 2005). The shift in our understanding of biodiversity and the increasing value that we put on it has heightened our concern about invasive species. Invasive species are among the top causes of losses in native biodiversity worldwide (Sala et al. 2000), and play a role in the imperilment of nearly half the extinct and endangered species in the U.S. (Wilcove et al. 1998). For those people who value biodiversity, invasive plant species are a threat.

Despite our increasing understanding of the threat invasive plants pose to biodiversity, the debate surrounding invasive plant species endures, with convincing arguments on both sides of the issue.

For Invasive Weeds:

- No living thing is intrinsically bad.
- Weeds have adapted superior dispersal and fecundity mechanisms and are simply "the fittest." As Darwin describes, it is a natural process for the best adapted creatures to survive and the lesser adapted creatures to die off.
- Weeds do not need our care or maintenance. They grow well in our gardens, yards, and roadsides.
- Many invasive plants have beautiful flowers. They help beautify our landscapes.
- Invasive plants can be very useful. They spread and grow quickly especially in places where human disturbances have occurred. We can use invasive plants to prevent erosion and re-vegetate after construction or mining.
- Invasive plants and weeds grow naturally. It is not our job to stop them. They are a part of nature.

Against Invasive Weeds:

- Invasive weeds threaten biodiversity, and even can cause local extinctions

(extirpations) of rare or endangered species.

- Invasive weeds cost us over $34,000,000,000 dollars per year in the United States to manage and remove (Pimentel et al. 2000). Imagine the money we'll save if the problem doesn't get out of control in Alaska!

- Invasive weeds interfere with crop and livestock production which we depend on for food.

- Invasive plants can change habitats, disrupt food webs, and negatively impact wildlife.

- Some invasive plants, like cheatgrass, can make fires occur more frequently (D'Antonio 2000).

- Invasive weeds negatively impact ecosystem services to humans (aesthetics, recreation, economics, health).

In this lesson, students will learn about different perspectives in the invasive species debate, and make their own decision on whether it is worth the time and effort to protect Alaska from invasive plants.

ADVANCED PREPARATION ✦

- Make a copy of the "Invasive Weed Values Survey" for each student

PROCEDURE ✦

1. **(Gear-Up)** Offer the students an alternative perspective to invasive weeds by discussing the folktale "Love the Weeds."

Love the Weeds

A folktale from Iran,
as retold by Margaret MacDonald, in *Earth Care: World Folktales to Talk About*, August House Publishers, Little Rock, Arkansas, 2005.

Once the Mullah tried gardening. He planted all sorts of seeds in his garden and waited for the beautiful flowers to spring up and bloom. A few did come up. But alas, the garden was mostly filled with unsightly weeds. They grew more quickly than the flowers. And they too budded, bloomed and distributed wafts of seed.

In desperation the Mullah made his way to the palace to consult the palace gardener. This man was known for his skill with plants.

"I have tried everything," complained the Mullah. "I pull them out. I hoe them out. I plant more flower seeds. And what do I come up with? Weeds! Weeds! Weeds!"

The gardener considered all this for a while. Then he offered his wise advice: "I think the best thing for you to do… is learn to love the weeds."

2. Was the palace gardener right? Should we just learn to embrace invasive weeds? Many of the invasive weeds have just as beautiful flowers as the ones the Mullah was probably trying to grow. They are a part of nature. Why should we struggle to get rid of them? They grow great, and we don't have to worry about taking care of them. Maybe we should "learn to love the weeds." Discuss with the students that

many people feel as the palace gardener does. The decisions that we make about invasive plant species are based on human values.

3. **(Explore)** Allow students to explore their values surrounding invasive weeds by completing the "Invasive Weed Values Survey" included with this lesson. Read the value statements aloud to the students and have them check off if they agree or disagree with the statements. Have the students count the number of checks in the agree column for statements 1-5. Record that number on the bottom of the page. Next, have students count the number of checks in the "disagree" column for statements 6-10. Record this number and add it to the first. This is the survey score. The lower the survey score, the more a person's values are aligned against invasive weeds. Higher survey scores indicate values more aligned with letting invasive weeds continue to grow.

4. **(Generalize)** Discuss your answers to the survey. Have students describe why they chose to agree or disagree with each statement.

5. **(Interpret)** In sharing student answers, it becomes very apparent that the issue of invasive plants is not so black and white. The issue is complicated by the many perspectives and human values. Are invasive plants bad? It is hard to say if invasive plants are all bad or all good.

EVALUATION ✦

Read the two articles published in two consecutive days in the Fairbanks Daily News-Miner. One presents a poetic view of invasive plants, where their beauty and ability to recover quickly after disturbances is an inspiration to the author. The article published on the next day presents a scientific view, which highlights the impacts invasive plants can have on human values such as agriculture, biodiversity, the environment, and the economy.

Have students discuss the articles in small groups. What are the perspectives of each author? What human values did each author use to develop their perspective on invasive plants? Can you guess how each author would have scored on the "Invasive Weed Values Survey"? Have students write a paragraph or two explaining how human values influence our perspective on invasive plants. What human values would make invasive plants seem good? What human values would make invasive plant seem bad?

EXTENSIONS ✦

- Survey other students in your school, or take the surveys home to give to their family members. Create a bar graph of how many people scored as having values aligned against invasive weeds and how many people scored as having pro-weed values. What does this say about your school or your families? How educated were your schoolmates or families about invasive plants in Alaska? Do you think that would make a difference?

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Name _____

Invasive Weed Values Survey

	Value Statement	Agree ☺	Disagree ☹
1	A field of purple vetch flowers looks better than a field of grass or bare dirt.		
2	It is worse to spray herbicides (chemicals used to kill invasive plants) on a large patch of invasive plants than it is to let them continue to grow and spread.		
3	The orange flowers of orange hawkweed are beautiful. We should let it grow to make the roadsides more beautiful.		
4	After mining or construction, plants that grow as quickly as possible should be used to stabilize the soil and protect water resources, even if they are invasive plants.		
5	No living thing is bad, not even invasive plants.		
6	Alaska's native plant biodiversity is important.		
7	We should protect our national parks and wildlife preserves from invasive weeds.		
8	Alaska will save a lot of money in the long run if we prevent invasive plants from spreading.		
9	I should tell my neighbor to kill the pretty purple loosestrife that they have growing in their yard.		
10	It makes me concerned when I see white sweetclover growing in a parking lot near the river.		

Backyard wilderness, whether seed or foreign weed, still brings joy

By Theresa Bakker
Published in the Fairbanks Daily News-Miner, Sunday, July 13, 2008

FAIRBANKS -- I finally gave up. Every year I tried to plant vegetables in my tired plots. Too lazy to add new soil or build some raised beds, I defined insanity by plunking down fistfuls of cash for hardy starts budding with the promise of abundance.

And every year the same thing happened. Nothing.

Sure, the plants grew a bit, what wouldn't in this land of wet and warmth, the sun pulling all-nighters so even my dumb-start developmental offerings had a chance. No vegetables, though, nothing like what my produce-sharing neighbors got, prompting moans of too many zukes and an overabundance of roots.

This year was different. I decided deep in the stasis of winter, having secured us a regular spot in our favorite Community Supported Agriculture farm, that I would let the garden areas go wild, as an experiment of sorts. I wanted to see what would grow if I just left the dirt alone.

Actually, I started a couple of years ago with the smallest plot. Inhospitable and life sucking, each healthy start would settle into the dirt dense with roots and — just exist. The ground already belonged to a plant I didn't recognize by its pointy new spears, reddish green and ropy when I tried to pull them out, holding on to the earth like a kitten clings to a sock, all claws and nothing to lose.

When I got pregnant with my son, I decided to save my maternal attentions for a more promising patch. So I let that squatter take over. And by the following year there was a leafy green bush there, vibrant with leaves carrying a trace of a five o'clock shadow and thorns, not quite the dew-claw daggers of a rose, but sharp still the same.

I figured Sitka roses, since they flourish in the empty lots along our street, but the following summer brought tight white blooms that fell off to reveal the unmistakable gems of a raspberry bush. Who knew what dormant treasures were waiting in the rest of my yard? Maybe ferns unfurling with a wave to the madness of spring, majestic irises or some other local celebrity.

What I got was mostly weeds, but some of my favorite plants bear that name. At my friend Lynne's house, I admired a succulent stalk with stunning leaves. She told me it was called jewelweed, easy to transfer and easily reaching heights in excess of five feet. That's the plant for me, I thought. She promised to give me some starts.

Later that day at an event sponsored by the Friends of Creamer's Field, she found a brochure about invasive non-indigenous plants; a most wanted list featuring the star of her own yard in its centerfold.

I've admired many of those same plants, counting them among the welcome intruders in my backyard wilderness. The alluring butter and eggs, with its towering stalks and snapdragon-shaped flowers; the aromatic bird vetch sprouting in billowing clouds of cobalt blue; and the stately Siberian pea shrub, recommended as a good privacy shield by the utility workers

who came to trim back our unwieldy trees.

Weed is a label that's thrown around like dandelion seeds, so it's hard to know when we should be cautious. Fireweed, considered invasive in Europe, is one of my favorite plants. Watching it sprout in meadows along the Kenai Peninsula helped me decide to stay. If this is what Alaska calls a weed, I thought, I must be in the right place.

I know scientists have the best interest of the ecosystem in mind when they release these lists of noxious plants, but I can't help wonder whether somebody might just banish me from the Garden of Eden I've made for myself.

Like the Freeze Frame cartoon by Fairbanks artist Jamie Smith featuring a white professor, who says, spit flying and zeal emanating, "We must act now to eradicate any non-indigenous invasive species! Once established, there's no telling what havoc they will wreak upon the natural order!!" I'm with the Native man in the audience who says simply, "OK. Get out."

Some of the invasive species on the list are actually useful. There's pineappleweed with a sweet scent released by a pinch of its velvet flowers, aromatherapy for my sun-stroked soul. Chickweed, which is good in salads. Even lambs quarters, with an iron and protein content higher than spinach, which is much harder to grow in my garden. Maybe that's one way to stop the spread. Harvest edible weeds before they go to seed and toss them into the dinner.

Most of these weeds are here because of us anyway. Newly disturbed land encourages growth for the first act that comes to town. They sprout up along new trails and hitchhike into national parks on our wheels.

I'm fascinated by the way destruction benefits the ecosystem. The way wildfire helps spread some of these plants like a gardener tilling the land. My husband is a firefighter and he's the wildfire in our garden, cutting down trees and tearing up the raspberry bush in the spring when it's time to remove the snow.

I think of him as a destructive force, an interloper messing with my wilderness. And then I'm awed by the rejuvenating power of his actions when the raspberries come back twice as thick and abundant as before.

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Controlling the spread of invasive plants

By Diane Claassen
Published the Fairbanks Daily News-Miner, Monday, July 14, 2008

Finally it is summer in Fairbanks, with warm weather and lush green growth all around us. Wildflowers are showing off their bright yellows, purples, pinks and blues. Arnica, fireweed, bluebells, wild sweet pea and others adorn the roadsides.

All is well. Or is it?

Among these wonderful native wildflowers are "imitators"; plants that lead us to believe that because they have beautiful flowers and lush green growth, they are harmless and wonderful also.

These are what are referred to as exotic plants. They have been introduced into Alaska for many different reasons: as forage crops, food sources, garden plants and by "hitch-hiking" on the wheels of vehicles or with animals.

It does not matter how they arrive, but how we can stop them from spreading any farther in our state.

Education is one of the best ways to control the spread of invasive plants. The more that is known, the more able we are to deal with the problem. So to begin, here are a few terms that are helpful when talking about plants: native species, exotic species, weeds, invasive species and noxious species.

- A native species occurs in an area without human assistance.
- An exotic species is introduced by humans to locations outside its native range.
- A weed is an undesirable plant, native or exotic, that can typically thrive on disturbed soils.
- An invasive species invades natural areas and can cause harm to the economy, environment, public health or all of the above.
- A noxious species has been outlawed by a state because of its dangerous potential.

Invasive weeds have an impact on agriculture, biodiversity, the environment and our economy. Weeds reduce crop and pasture productivity as well as being second only to habitat destruction as a threat to biodiversity. Some environmental impacts include water quality, fire frequency, wildlife and fish habitat and toxicity to humans, animals and native plants. Billions of dollars are spent every year in the United States to control these weeds.

Alaska has an opportunity to prevent the spread of invasive weeds because the plants have not gotten a good foothold here yet. We still have large intact native ecosystems, and by following some guidelines we can protect our state from the spread of invasive weeds.

Bird vetch, White Sweet Clover, Perennial Sowthistle, Foxtail Barley, Hemp-Nettle and Yellow Toadflax are of main concern in the Fairbanks area. The first three plants listed are in the greatest numbers and are the most serious threats.

Here are a number of ways to help:

- Don't plant a problem. The UAF Cooperative Extension Service has a list of plants that should not be planted in Alaska. Please contact us.
- Don't use fill dirt from weedy sites and clean equipment before tilling or moving soil into your yard.
- Brush soil and seeds off clothing and animals.
- Purchase certified weed-free hay and straw, and watch nursery stock for weeds.
- Don't dig up plants from roadsides and take them home. Join local groups that are involved with invasive species programs.
- Volunteer to pull weeds.

If you want to learn more about invasive plants; please contact the Integrated Pest Management Program at the Alaska Cooperative Extension Service, a part of the University of Alaska, Fairbanks, working in cooperation with the U.S. Department of Agriculture.

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Lesson 17

Community Perspectives on Invasive Plants

Grade Level: 5-6
Alaska State Science Standards: SE1.1[3-6], SE2.1[3], SE2.2[4,5], SF1.1[3-6], SF2.1[3-6], SF3.1[3-6]
Subject: Social Studies
Target Skills: Communication, interpreting information
Duration: 60 minutes
Setting: Classroom
Vocabulary: perspectives, law, policy, ordinance

INSTRUCTIONAL GOAL ✦

Students will understand that the choice to manage and control invasive plant species in Alaska is based on human value systems.

PERFORMANCE OBJECTIVE ✦

Students will assume roles of Alaskan community members and conduct a mock city council meeting on a potential invasive plant ordinance for the community.

MATERIALS ✦

- "Community Perspective Cards"
- Paper and Pencil

TEACHER BACKGROUND ✦

In this lesson, students will continue to develop their understanding of the role human values play in our management of invasive plant species. Students will apply their understanding of different perspectives that people can have

on invasive plants. (See previous lesson "Love the Weeds.")

As their occurrence in Alaska increases, invasive plants can affect the lifestyles and livelihoods of community members in many different ways.

For people using Alaska's native plants and animals for commercial or subsistence purposes, invasive plants can seriously impact their livelihoods. As demonstrated in earlier lessons, invasive plants threaten the diversity and abundance of plants and animals that people depend on for food, recreation, and aesthetics. For fisherman, invasive plants can affect fish populations by altering stream chemistry, hydrology, and food webs. For hunters, invasive plants can displace game species. For businesses dependent on tourism, scenic values of Alaska's wilderness could be compromised by invasive plants causing a loss of tourists. For farmers, gardeners, and people who depend on agricultural products in Alaska, invasive plants are a threat to crops and can reduce the crop yields.

There are many lifestyles and livelihoods where controlling invasive species is an inconvenience or added cost. For example, in construction it is difficult to ensure gravel will be free of invasive plant seeds. People who care for animals such as horses or sled dogs, need hay and straw for their animals. Many invasive plants can enter Alaska in hay bales (Conn 2006). Weed-free certified hay is becoming more readily available in Alaska, but it costs a bit more than the standard hay because it is more expensive to produce. Business owners in the gardening industry could lose money if they were required to ensure their potting soil was invasive plant free. In addition, some of their best selling plants could be invasive, but people love to buy them because they grow so well in Alaska. For example, Siberian peashrub is a top seller for landscapers and plant sellers at farmer's markets and greenhouses because it grows so well in Alaska. Recently, however, this non-native species has started to spread to undisturbed boreal habitats in some parts of Alaska (Lapina et al. 2007).

It is important for people to understand how invasive plants influence their local community. Before making decisions about invasive plant policies in Alaska, land managers and policy makers must gather a variety of community perspectives.

In this lesson, students will learn about the different perspectives that must be considered before establishing regulations and laws regarding invasive plants. In Alaska, the first state invasive plant legislation was signed into law in 2008. The law created a government position designed to establish a statewide management plant for invasive plants and coordinate invasive plant control, research, and education efforts around the state (ASL 2008). It was a big first step in state government leadership on this issue in Alaska.

In other states, city or state ordinances have been established to help protect local habitats and economies from the impact of invasive plants. For example, the state of Florida prohibits listed plants from cultivation, introduction, collection, and transport without a permit (FDACS 2008). In the city of Chicago, a city ordinance has been passed regulating the transport of aquatic invasive species such as purple loosestrife and Eurasian watermilfoil (Chicago DOE 2007). The federal government also has legislation which defines and regulates very problematic species legally termed "noxious" plants. The United States Department of Agriculture and Consumer

Services administers the Federal Noxious Weed Act. Plants listed under this rule are prohibited from importation and interstate transport without a permit (APHIS 2008). All these laws required much research, collaboration, and compromise to make them effective protective measures against invasive plants.

ADVANCED PREPARATION ✦

- Make a copy and cut the "Community Perspective Cards."

PROCEDURE ✦

Activity adapted from "Little Piece of Forest" in *The Role of Fire in Alaska* by U.S. Fish and Wildlife Service.

1. **(Gear-Up)** Set the scene for the role playing activity exploring community perspectives on invasive plants. The students will play the roles of city council members and townspeople and conduct a mock community meeting.

   Scenario:
   Your town has drafted an ordinance that makes it unlawful to possess problem invasive plant species. The ordinance establishes penalties for anyone who imports, sells, transports, owns, or otherwise possesses any of the plant species or seeds of species indicated as highly problematic plants in the *Invasive Plants of Alaska* book. Before the ordinance is enacted, there is a period of public comment. All sorts of community members have gathered to testify on whether or not they agree with the ordinance

2. **(Explore)** Hand out the community perspective role cards included with this lesson. Students read the cards and develop their stance on the proposed invasive plant ordinance. They will deliver a testimony to the city council. Allow students a period of think time to fast write on their opinion.

3. The teacher will preside over the meeting by calling up the community members to testify one at a time. Each student has 1-2 minutes to deliver their testimony. Give the city council members a brief period to ask questions to each community member after they have testified.

4. **(Generalize)** After all community members have testified, the city council meeting will take a brief recess. During this time period, have students, still in character, write a second fast-write. Has their opinion on the issue changed after listening to all the other community members? If so, what made them change their mind? What would do the most good for the community in the short-term? Having the ordinance or not? Why? What would do the most good for the community in the long-term?

5. **(Interpret)** Call the council meeting back to order. The city council will now vote on the proposed invasive plant ordinance. City council members will read their second fast write, presenting what they think would be the best for the community, then cast their vote.

EVALUATION ✦

Create an evaluation rubric assigning points for student participation in the mock city council meeting, and points for the two fast writes used to develop and re-

assess their perspectives on the invasive plant ordinance issue.

EXTENSIONS ✦

- Interview a variety of community members and document how invasive plants affect their lives (greenhouse and nursery managers, park and preserve managers, gardeners, people involved in the construction industry, scientists, politicians, etc.). Students should write reports on their interviews.

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Community Perspective Cards

Farmer: Weeds cost you a lot of time and money to remove from your crops. Invasive plants on the roads, and in the land neighboring your farm are constantly putting seeds back into your soil. You are trying to keep your land weed-free, but your neighbors don't seem to care.	**Gravel Pit Owner:** You sell gravel to the people who build roads and buildings in Alaska. It would cost you a whole lot of money to make sure your gravel didn't have any invasive plant seeds in it. It seems impossible to get the seeds out of gravel.
Invasive Plant Scientist: You study invasive plants in Alaska and have found that invasive plants are spreading rapidly into areas that had always been pristine. Your data shows that invasive plants are having a negative impact on the other plants and animals in the ecosystem.	**Bird Watcher:** You love watching birds in all sorts of habitats. You noticed that fewer species of birds are visiting one of your favorite bird watching areas. You wonder if it has to do with the explosion of an invasive plant that seems to be completely taking over. You notice that no animals seem to be eating the plant, not even insects.
City parks director: You recently planted hundreds of European bird cherry trees in parks around town. While it is not listed as a very problematic species in the *Invasive Plants of Alaska* book, European bird cherry is on the list of species to watch in the future. If the species becomes problematic in the future you'll have to cut the trees down. They cost you so much time and money to plant.	**Wildflower collector and enthusiast:** You love wildflowers of all sorts. You like to collect as many new types of blossoms as you can and make them into pressed flower art. Many plants that you collect are not native to Alaska, but you understand that invasive plants could reduce the diversity of native flower species.

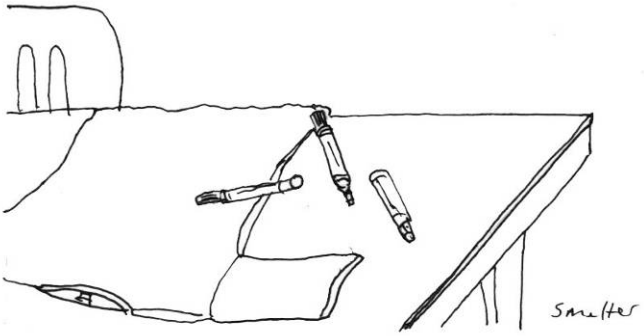
Nursery Owner: You sell all sorts of plants that aren't native to Alaska. Plants native to Alaska don't seem to sell as well as the exciting and exotic plants. The leafy spurge and the purple loosestrife are some of your best selling plants.	**Photographer:** You make your livelihood taking dramatic pictures of Alaskan landscapes. You are afraid that it will be harder to sell your photos if people see invasive flowers in the foreground rather than the native Alaskan flowers.
Wildlife Preserve Manager: Your preserve has isolated patches of invasive plants in it. You organize committees and volunteers each year to pull invasive plants in your preserve. You think a town ordinance prohibiting invasive plants would greatly help protect and preserve the wildlife on your lands.	**Gardener:** You are constantly pulling weeds in your garden, but you know that some gardeners bring plants from other places without knowing that they are problem species. You think it is unfair to punish gardeners for not knowing that they posses a problem plant.
Landowner: You have some property in rural Alaska, and plan on someday building a cabin out at the site. A few years ago you cut a trail into the property and now the trail is overrun with weeds. It seems like it would take a lot of effort to get rid of them. You think the town should not be telling you what plants you can or cannot have on your private property.	**Dog Musher:** You use straw as bedding for your dogs. Every summer you notice new kinds of plants growing in your dog yard. You noticed that the seeds easily get stuck in your dogs' fur. You read in the newspaper that scientists in Alaska have discovered that many new invasive species have been coming to Alaska in straw from the lower 48. Weed-free certified straw is available, but it will cost you more than you can afford to buy.

Religious Leader: You believe all living things deserve to live. It is a central part of your faith. You believe invasive plants have a right to live just like everything else. They are part of creation. You think that saying invasive plants don't belong here is like saying immigrants from other countries don't belong in the United States. That's not right!	**Hunter:** You are an avid hunter of moose, caribou and waterfowl. You know that these animals depend on Alaska's native plant species. You think invasive species could put your favorite hunting areas at risk.
Tourism Business Owner: Your customers come to Alaska to see wilderness like they've never seen before. You don't want them to see invasive plants everywhere. You want tourists to continue to come and know they can find an Alaska that stands apart in the quality of its pristine wilderness.	**Berry Picker:** You are an elder in your community and have been collecting wild berries for your entire life. You preserve them as jams, make agutuk ("eskimo ice cream"), and freeze them as food for the winter. After a recent fire, the blueberries have been coming back even stronger than before, but you notice an invasive plant starting to move into the area from the roadside.
Artist: You used to have a garden, but have been too busy this summer to plant anything. To your delight, the beautiful ornamental jewelweed has started to grow, along with several other pretty flowers. You know they are invasive plants, but you like the flowers. They are beautiful. They inspire you to create your art. They have just as much a right to live as any other living thing.	**Invasive Plant Control Expert:** You study ways to control invasive plant species. Your research shows that for some widespread species in the town, hand pulling and mowing will not be enough to get rid of them. Herbicides will have to be used. You have tested the chemicals and know that they can be used safely. However, chemical control will be costly and will definitely stir up community emotions on herbicide use.

City Council Member #1: Your spouse is a lawyer and you stay at home. You have a nice home with great landscaped lawns. You have your lawns professionally done and your gardeners spend a whole lot of time weeding in your yard.	**City Council Member #2:** You are a hardware store owner. You are very concerned about the budget of the project. It will bring some financial burden to small business owners such as greenhouse owners, hay and feed store owners, gravel pit owners. You believe that the best government is the government that doesn't interfere with people's lives and livelihood.
City Council Member #3: You live in a cabin outside of town and love hunting and fishing. You are not sure of what invasive plants could do to your favorite pastime. You need to listen to the perspectives of the community members before you make up your mind.	**City Council Member #4:** You keep up to date on all the research and news on invasive plants. You know the impacts invasive plants have on ecosystems, but also know that our invasive plant problems are nowhere near as bad as in your old hometown in Oregon. You think we need more research before the town takes such drastic measures.
City Council Member #5: You are retired and very civic minded. You are worried that the ordinance could raise taxes. Your house has Siberian pea shrub surrounding it as a natural fence. You know this plant is listed as a potential problem species. You'd be willing to cut your shrubs down if it was the best thing for the community. You need more information to decide on the ordinance.	**City Council Member #6:** Environmental conservation is one of your highest values. You know that it is important to conserve Alaska no matter what the cost. The reason you moved to Alaska and stayed here for so many years was because you loved the beauty of Alaska's wild habitats. There is no question that you support the proposed ordinance.

Lesson 18

Weed Wear



Grade Level: K-6
Alaska State Science Standards: SF1.1[3-6]
Subject: Art, Civics, Science
Target Skills: Communication
Duration: 60 minutes
Setting: Classroom
Vocabulary: slogan, community awareness

INSTRUCTIONAL GOAL ✦

Students will understand the power of clothing as public awareness and outreach tool.

PERFORMANCE OBJECTIVE ✦

Students will design and create gloves and t-shirts to wear while pulling invasive plants.

MATERIALS ✦

- Cloth gardening gloves (white or gray)
- Permanent markers (all colors)
- T-shirts
- Scanner
- Ink-jet printer or copy machine
- Iron-on transfer paper (Available in the t-shirt making section of craft stores. Transfer paper is available for use with both ink-jet printers and copy machines.)
- Iron and ironing board
- Scissors

TEACHER BACKGROUND ✦

Making "weed wear" clothing is an excellent way for students to get creative and educate the people around them on invasive plants. When students at Denali Elementary School in Fairbanks learned about the dangers that invasive bird vetch (*Vicia cracca*) could pose to Alaska's habitats, they brainstormed ways to get the message out to their community. One of the student ideas was to create an entire

bird vetch awareness outfit—complete with hat, shirt, pants, gloves, even shoes that said "Stomp out Bird Vetch!" They stuck with the t-shirts and garden gloves! They wore their shirts when invasive plant experts came to the classroom as guest speakers, when they presented their "Aliens in Alaska's Forest" science fair project, when they ran an invasive plant awareness booth at the local earth day fair, and, best of all, they wore the shirts during their culminating weed pull the last week of school! Encourage your students to wear their "Weed Wear" around town. The more people see them, the more people will be familiar with invasive plant issues in Alaska.

Figure 18.1 "Weed Destroyer" garden gloves designed by Jack Kendall, age 7.

ADVANCED PREPARATION ✦

- Purchase iron-on paper.
- Assemble materials.
- Students should bring in a blank t-shirt and pair of garden gloves.

PROCEDURE ✦

Making Weed Pull Garden Gloves:

1. Have students illustrate designs with permanent markers on the back of the white or gray cloth garden gloves.
2. Encourage the use of color, illustrations of their favorite invasive plant, or catchy slogans in their design. Check out this pair of "Weed Destroyers" created by first grader Jack Kendall from Fairbanks (Figure 18.1).

Making Weed Awareness T-shirts:

1. Have students create a T-shirt design on a sheet of paper. Designs should be bold and in black and white (if using copy machine compatible transfer paper) or color (if using ink-jet printer compatible transfer paper). Figure 18.2 shows some designs created by first grade students at Denali Elementary, Fairbanks, AK.
2. For ink-jet printer designs, scan designs into the computer. Add slogans or invasive plant awareness information using word art software.
3. Print or copy designs on iron-on transfer paper.
4. Trim excess paper from the edges of the design.
5. Set iron to cotton setting. Peal paper from the back of the design and position on t-shirt. Hold iron in place for 15-20 seconds on all parts of the design.
6. Follow iron-on transfer paper manufacturer's instructions for washing t-shirts with designs.
7. Have students wear t-shirts to invasive plant awareness events held by your class, including science fairs or service learning weed pulls.

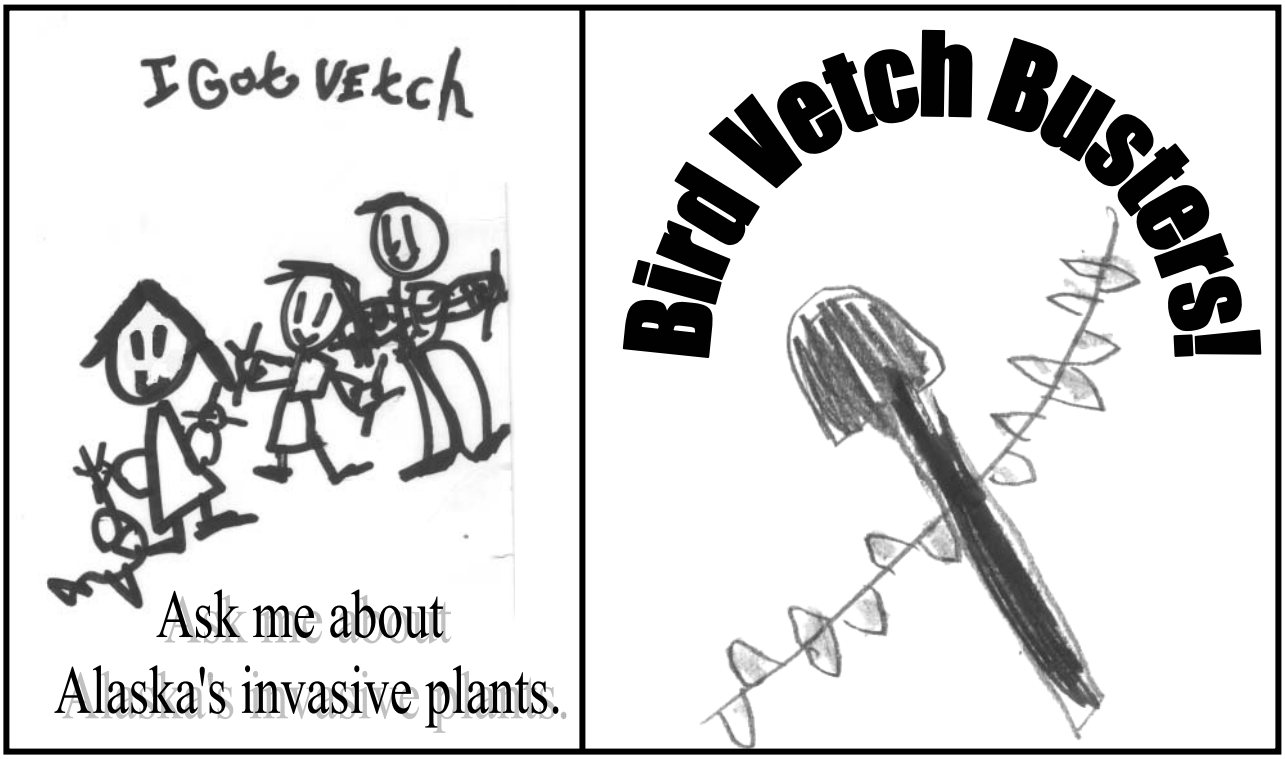


Figure 18.2 T-shirt designs created by first graders Sydney McKilligan and Jack Kendall during their study of invasive bird vetch.

EVALUATION ✦

Create a rubric to assess the student effort, drawing quality, slogan, and creativity on the "Weed Wear" projects.

EXTENSIONS ✦

Encourage students to don their "Weed Wear" when invasive experts come as guests to your classroom, when students present invasive plant experiments or projects, and, of course, every time the students pull invasive weeds!

Lesson 19

Service Learning Weed Pull

Grade Level: K-6
Alaska State Science Standards: SA1.1-1.2[3-6], SA3.1[3-6], SC1.1[3,4], SC3.1[3-6], SE1.1[3-6], SF1.1[3-6]
Subject: Science, Civics
Target Skills: Observation, communication, using space/time relationships, inference, prediction
Duration: 2 hr field trip and two 30 minute classroom sessions
Setting: wildlife preserve, park, or local invasive plant infestation site, and classroom

INSTRUCTIONAL GOAL ✦

Students will learn to effectively pull invasive plants and feel empowered to make a positive difference in their community and habitat.

PERFORMANCE OBJECTIVES ✦

1. Students will serve their community and protect Alaska's native biodiversity by conducting a weed pull in a local park, wildlife preserve, or their own schoolyard.
2. Students will practice positively identifying invasive plants in the wild.

MATERIALS ✦

- Flip-panel activity worksheet
- Gardening Gloves
- Plastic trash bags
- Adult chaperones
- Map of infestation area
- Photo of focal plant or "Selected Invasive Plants of Alaska" pocket guide.

TEACHER BACKGROUND ✦

Kids have tremendous power to positively influence their community. The issue of invasive plants in Alaska is an

issue where kids can make a tangible difference. The impact kids can have in Alaska is greater than in any other state. Most invasive plant species in Alaska have not yet gone beyond control. Because the issue is so new for our state, every weed a kid pulls, or every person that a kid talks to about alien plants, helps protect Alaska from the spread of invasive plants. This lesson empowers students to be advocates for Alaska's future, and to educate their community on invasive plants. Education is the key to preventing the introduction of new invasive species in Alaska. As the old adage goes, "An ounce of prevention is worth a pound of cure."

In this lesson, students will choose a location infested with one or more invasive plant species. This could be a wildlife preserve, park, or a nearby piece of land. This activity is an excellent opportunity for the families of your students to get involved in the class' study of invasive plants. When parents understand the ideas that children are passionately exploring, learning is even more powerful as it becomes trans-generational. The kids feel good about teaching their families, and spreading important information that can help conserve Alaska's natural habitats.

ADVANCED PREPARATION ✦

- Locate a local infestation area. If you plan on working at a wildlife preserve or park, be sure to contact the land managers to obtain permission.
- Choose a focal species (particularly for younger students).
- Obtain or draw a map of the area and highlight target weed pull areas. If the infestation is vast, talk with land owners about mowing the area, and have students pull in areas closest to where the invasive plants have or could move into natural habitats.
- Make sure each student has a pair of gardening gloves, and a trash bag.
- Make copies of a picture of the focal species, or obtain several copies of the "Selected Invasive Plants of Alaska" pocket guide.
- Invite family members to attend the weed pull.
- Make double sided copies of the flip-panel activity worksheet. The paper will be folded lengthwise with the pictures and writing space on the inside of the fold.

PROCEDURE ✦

1. **(Gear-Up)** Make posters and invitations to advertise your weed pull. Distribute them to parents, around your school, or around your community.

2. **(Explore)** Have students predict where they think they'll find the most invasive plants. They should use the information they have gained through the prior lessons and inquiries. On the flip panel worksheet provided with this lesson, instruct the students to draw a picture and write a few sentences on where they would expect to see the most invasive plants occurring in their pull area. This belongs under the prediction window of the flip panels. Students should explain why they thought this. Will it grow in an open area? Under the trees? On trails or in parking lots? Why?

3. **(Generalize)** Review with the students why you are conducting a weed pull. Review how to identify your target species. What color flowers? What kind of stem and leaves? Should you

pick anything that doesn't match this description??? NO!

4. **(Generalize)** Teachers should discuss important parts of conducting a weed pull.

How do you pull an invasive plant so that it doesn't come back?

Pull the plant so you get as much of the root as possible. Many invasive plant species can grow back from pieces of root left in the ground. Talk to a local land manager or a cooperative extension integrated pest management technician to determine the best method for pulling your target species.

How do you dispose of invasive plants?

Put the plants in a plastic trash bag and tie it closed. Do not leave pulled weeds to mulch in a pile. They will still have a chance of emerging again. In a plastic bag, the plant parts will decompose and lose viability. If you want to be extra careful, have your plants burned at a local biohazard incinerator. Most research facilities at universities will have an incinerator. Ask the land owner for help disposing of the plants.

What is the best time to pull an invasive plant?

The best time to pull invasive plants is after they have flowered and are easy to identify, but before they have had a chance to produce seeds. July-August. It can be done in other seasons as well. In spring, at the end of the school year, you can pull emerging stems and help native plant seedlings get more sunlight by removing dead, matted invasive plant biomass.

5. **PULL!** Travel to the area, split up into smaller groups and assign groups different infestation areas according to your map. Pull, pull, pull!

6. **(Interpret)** Count number of bags collected. Sing the song "Pull, Mow and Spray" found in lesson "Invasive Plant Management: A Race Against Time." Cheer! Then dispose of your bags full of invasive plants.

7. **(Interpret)** Back in the classroom, return to the student predictions on where they thought they'd find the most invasive plants. Were they correct? Why did the plants seem to grow where they did? Have students write and draw what they saw before the weed pull on the second panel of their flip-panel activity sheet. Where were the most invasive plants actually growing? Write if their prediction was correct or incorrect. Finally, have students draw and write what the site looked like after they had pulled the invasive plants. Did they make a difference?

EVALUATION ✦

- Use the completed flip-panel activity sheet as an assessment of student understanding on invasive plant preferred habitats and understanding of the difference they made in a habitat by conducting the weed pull.

- Gauge the success of your weed pull by looking at the volume of invasive plants pulled and the level of community participation.

EXTENSIONS ✦

- Wear student-designed t-shirts and gardening gloves to the weed pull.
- Invite media to cover your community service weed pull. Newspaper, TV, and radio reporters love featuring kids!
- Have students in grades 3-6 write their own articles on the weed pull and submit it to a school or local newspaper.
- Enter your class infestation location in the statewide invasive plants database and record what control actions you took. Enter data at http://akweeds.uaa.alaska.edu/.
- Look up other areas of infestation of your focal species on the Alaska Exotic Plant Information Clearinghouse (AKEPIC) available at http://akweeds.uaa.alaska.edu/.

REFERENCES ✦

Alaska Exotic Plant Information Clearinghouse (AKEPIC). 2008. Non-Native Plants of Alaska. Alaska Natural Heritage Program, UAA USDA, Forest Service, State and Private Forestry Available: http://akweeds.uaa.alaska. edu/.

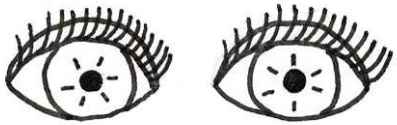
U.S. Forest Service. 2007. *Selected Invasive Plants of Alaska*. Pocket guide. Available: http://www.fs.fed.us/r10/spf/fhp/weed_book/

Figure 19.1 Denali Elementary students in Fairbanks, Alaska, pulled invasive bird vetch in the spring and the fall to help protect a local wildlife refuge.

Fold Here

Prediction…

Where do you think you'll find the most invasive plants?



Observation of the area before the Weed Pull

Were you right?

Observation of the area after the Weed Pull

Did you make a difference?

Draw a picture of your prediction.

Draw a picture of your observation.

Draw a picture of your observation.

Inside of Fold

Describe:

Describe:

Describe:

WEED WACKERS! Alaska State Standards Correlations by Standard

****Science Standards do not exist in the state of Alaska for K-2 Grade Levels. National Science Standards for K-2 classrooms are similar to the science standards for older grade levels in Alaska. Standards listed in the following tables are for grades 3-6.**

Standard A1 - Science as Inquiry and Process

Standard SA Students develop an understanding of the processes and applications of scientific inquiry	**Correlating WEED WACKERS! Activity**	**Correlating Grade Level Expectations**	**Grade Levels**
SA1: Students develop an understanding of the processes of science used to investigate problems, design and conduct repeatable scientific investigations, and defend scientific arguments.	• On the Case	SA1.1	3-6
	• Invader Weapons	SA1.1-1.2	3-6
	• Weed Seed Germination	SA1.1-1.2	3-6
	• Weed Seeds & Climate	SA1.1-1.2	3-6
	• The Great Plant Contest	SA1.1-1.2	3-6
	• Invasives and Disturb. Field Study	SA1.1-1.2	3-6
	• Invasives and Disturb. Classroom Experiment	SA1.1-1.2	3-6
	• Not all Non-Natives	SA1.1	3-6
	• Weed Pull	SA1.1-1.2	3-6
SA2: Students develop an understanding that the processes of science require integrity, logical reasoning, skepticism, openness, communication and peer review.	• Invasion in Alaska	SA2.1	3-6
	• On the Case	SA2.1	5
	• Native or Non-Native?	SA2.1	3-6
	• Invader Weapons	SA2.1	3-4
	• Weed Seed Germination	SA2.1	3-6
	• Weed Seeds & Climate	SA2.1	3-6
	• The Great Plant Contest	SA2.1	3-6
	• Invasives and Disturb. Field Study	SA2.1	3-6
	• Invasives and Disturb. Classroom Experiment	SA2.1	3-6
	• Not all Non-Natives	SA2.1	3-6
	• Love the Weeds	SA2.1	3-6
SA3: Students develop an understanding that culture, local knowledge, history, and interaction with the environment contribute to the development of scientific knowledge, and that local applications provide opportunity for understanding scientific concepts and global issues.	• On the Case	SA3.1	3-6
	• Invader Weapons	SA3.1	3-6
	• Invasives in Food Web	SA3.1	3-5
	• Weed Seeds & Climate	SA3.1	3-6
	• The Great Plant Contest	SA3.1	3-6
	• Invasives and Disturb. Field Study	SA3.1	3-6
	• Invasives and Disturb. Classroom Experiment	SA3.1	3-6
	• Weed Pull	SA3.1	3-6

Standard C1 - Concepts of Life Science

Standard SC Students develop an understanding of the concepts, models, theories, facts, evidence, systems and processes of life science	**Correlating WEED WACKERS! Activity**	**Correlating Grade Level Expectations**	**Grade Levels**
SC1: Students develop an understanding of how science explains changes in life forms over time, including genetics, heredity, the process of natural selection, and biological evolution.	• Intro to Plants	SC1.1	3,6
	• Weedy Definitions	SC1.1	3,5
	• On the Case	SC1.1-1.2	3,4
	• Native or Non-Native?	SC1.1/ SC1.2	3-5/3,6
	• Invader Weapons	SC1.1/ SC1.2	3-6/3,6
	• Weed Seed Germination	SC1.1	3
	• Weed Seeds & Climate	SC1.1	3,4
	• The Great Plant Contest	SC1.1/ SC1.2	3,4/ 3
	• New Terr. for Weeds	SC1.1	3-5
	• Invasives and Disturb. Field Study	SC1.1	3-5
	• Invasives and Disturb. Classroom Experiment	SC1.1	3-5
	• Weed Pull	SC1.1	3,4
SC2: Students develop an understanding of the structure, function, behavior, development, life cycles, and diversity of living organisms.	• Intro to Plants	SC2.1-2.2	3-6
	• Weedy Definitions	SC2.1-2.2	3-6
	• On the Case	SC2.1-2.2	3-6
	• Native or Non-Native?	SC2.1-2.2	3-6
	• Invader Weapons	SC2.1-2.2	3-6
	• Invasives in Food Web	SC2.2	3-6
	• Weed Seed Germination	SC2.1-2.2	3-6
	• Weed Seeds & Climate	SC2.1-2.2	3-6
	• The Great Plant Contest	SC2.1-2.2	3-6
	• New Terr. for Weeds	SC2.1	3,5,6
	• Invasives and Disturb. Field Study	SC2.1-2.2	3-6
	• Invasives and Disturb. Classroom Experiment	SC2.1-2.2	3-6
SC3: Students develop an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy.	• Intro to Plants	SC3.1	3-6
	• On the Case	SC3.1	3-6
	• Invader Weapons	SC3.1	3-6
	• Invasives in Food Web	SC3.2	3-6
	• Weed Seeds & Climate	SC3.1	3,4
	• The Great Plant Contest	SC3.1	3-6
	• New Terr. for Weeds	SC3.1	3-6
	• Invasives and Disturb. Field Study	SC3.1	3-6
	• Invasives and Disturb. Classroom Experiment	SC3.1	3-6
	• Invasive Management	SC3.1	3-6
	• Weed Pull	SC3.1	3-6

Standard E1 – Science and Technology

Standard SE Students develop an understanding of the relationships among science, technology, and society	**Correlating WEED WACKERS! Activity**	**Correlating Grade Level Expectations**	**Grade Levels**
SE1: Students develop an understanding of how scientific knowledge and technology are used in making decisions about issues, innovations and responses to problems and everyday events.	• On the Case • Invasive Management • Community Perspective • Weed Pull	SE1.1 SE1.1 SE1.1 SE1.1	3,5 3-6 3-6 3-6
SE2: Students develop an understanding that solving problems involves different ways of thinking, perspectives, and curiosity that lead to the exploration of multiple paths that are analyzed using scientific, technological and social merits.	• Native or Non-Native? • Invasive Management • Community Perspective	SE2.1 SE2.1 SE2.1/ SE2.2	3-6 3-6 3/ 4,5
SE3: Students develop an understanding of how scientific discoveries and technological innovations are affected by our lives and cultures.	• Invasive Management	SE3.1	3-6

Standard F1 – Cultural, Social, Personal Perspectives, and Science

Standard SF Students develop an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives	**Correlating WEED WACKERS! Activity**	**Correlating Grade Level Expectations**	**Grade Levels**
SF1: Students develop an understanding of the interrelationships among individuals, cultures, societies, science and technology.	• Not all Non-Natives • Invasive Management • Love the Weeds • Community Perspective • Weed Wear • Weed Pull	SF1.1 SF1.1 SF1.1 SF1.1 SF1.1 SF1.1	3-6 3-6 3-6 3-6 3-6 3-6
SF2: Students develop an understanding that some individuals, cultures, and societies use other beliefs and methods in addition to scientific methods to describe and understand the world.	• Love the Weeds • Community Perspective	SF2.1 SF2.1	3-6 3-6
SF3: Students develop an understanding of the importance of recording and validating cultural knowledge.	• Love the Weeds • Community Perspective	SF3.1 SF3.1	3-6 3-6

Standard G1 – History and Nature of Science

Standard SG Students develop an understanding of the history and nature of science	**Correlating WEED WACKERS! Activity**	**Correlating Grade Level Expectations**	**Grade Levels**
SG2: Students develop an understanding that the advancement of scientific knowledge embraces innovation and requires empirical evidence, repeatable investigations, logical arguments, and critical review in striving for the best possible explanations of the natural world.	• Weed Seed Germination • Weed Seeds & Climate • The Great Plant Contest • Invasives and Disturb. Field Study • Invasives and Disturb. Classroom Experiment	SG2.1 SG2.1 SG2.1 SG2.1 SG2.1	3-6 3-6 3-6 3-6 3-6

WEED WACKERS! Alaska State Standards Correlations by Lesson

Lesson Title	Alaska Science Standard												
	SA1	SA2	SA3	SC1	SC2	SC3	SE1	SE2	SE3	SF1	SF2	SF3	SG2
Unit 1:													
Introduction to Plants				X	X	X							
Invasion in Alaska!?		X											
Weedy Definitions				X	X	X							
On the Case	X	X	X	X	X	X	X						
Native or Non-Native?		X		X	X			X					
Invader Weapons	X	X	X	X	X	X							
Invasives in the Food Web			X		X	X							
Unit 2:													
Weed Seed Germination	X	X		X	X								X
Weed Seeds and Alaska's Changing Climate	X	X	X	X	X	X							X
The Great Plant Contest	X	X	X	X	X	X							X
New Territory for Weeds				X	X	X							
Invasives and Disturbance: Field Study	X	X	X	X	X	X							X
Invasives and Disturbance: Class Experiment	X	X	X	X	X	X							X
Unit 3:													
Not All Non-Natives Invade	X	X								X			
Invasive Plant Management						X	X	X	X	X			
"Love the Weeds"		X								X	X	X	
Community Perspectives on Invasive Plants							X	X		X	X	X	
Weed Wear											X		
Service Learning Weed Pull	X		X	X		X	X			X			

Invasive Plant Resources for Alaskan Teachers

Find Invasive Plant Lessons:

Alaska Committee for Noxious and Invasive Plant Management (CNIPM). 2007. Invasive plant educational resources. Fairbanks, Alaska. Available: www.uaf.edu/ces/cnipm/k12.html

Center for Invasive Plant Management (CIPM). 2007. National invasive plant K-12 educational resources. Bozeman, MT. Available:www.weedcenter.org/education/edu_overview.html

Mittermaier, B. 2005. *Invaders of the Forest: Educators Guide to Invasive Plants of Wisconsin's Forest.* Wisconsin Environmental Education Board, Wisconsin Department of Natural Resources, and the Park People of Milwaukee County. Available: www.dnr.state.wi.us/org/caer/ce/eek/teacher/invasiveplantguide.htm

Montana Weed Awareness Curricula. Available: mtwow.org/teacher-curriculum

Slemmons, C. 2007. *Invasive Plants: Taking Root in Alaska*. 9-12 Invasive Plant Curriculum. Homer Soil and Water Conservation District. Available: www.homerswcd.org

Townsend K-12 School District Bug and Weed Curriculum. Available: http://townsendps.schoolwires.com/72291911222433/site/default.asp?

US National Parks Service. Aliens in Your Neighborhood Curriculum. Available: www.nps.gov/invspcurr/alienhome.htm

Learn About Invasive Plants:

Alaska Exotic Plant Information Clearing House. 2005. *Invasive Plants of Alaska*. Alaska Association of Conservation Districts Publication. Anchorage, AK.

Alaska Natural Heritage Program Non-native Plants of Alaska. Available: akweeds.uaa.alaska.edu

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Beck, Barbara. 1963. *The First Book of Weeds.* Watts Publishers. New York, NY.

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Montana Statewide Noxious Weed Awareness and Education Program. Available: www.weedawareness.org

National Invasive Species Info Center Available: www.invasivespeciesinfo.gov

The Nature Conservancy's Global Invasive Species Initiative. Available: tncweeds.ucdavis.edu

Podendorf, Illa. 1955. *The True Book of Weeds and Wild Flowers*, Children's Press. New York, NY.

Royer, F., and R. Dickinson. 2004. *Weeds of Northern US and Canada*. University of Alberta Press. Edmonton, Alberta.

Souza, D.M. 2003. *Plant Invaders*. Watts Library. New York, NY.

USDA Forest Service. 2006. *Selected Invasive Plants of Alaska.* USDA Forest Service Leaflet. Available: www.fs.fed.us/r10/spf/fhp/weed_book/index.htm

US Department of Agriculture, Plants Database. Available: plants.usda.gov

US Forest Service, Forest Health Protection (Alaska Region)
Available: www.fs.fed.us/r10/spf/fhp/

Vitousek, P. M., C. M. D'Antonio, L. L. Loope and R. Westbrooks. 1996. Biological invasions as global environmental change. *American Scientist* 84: 468-478.

Alaskan Invasive Plant Scientists Interested in Using Student Data

Anchorage

Helen Cortés-Burns
Botanist
Alaska Natural Heritage Program
University of Alaska Anchorage
707 A Street
Anchorage, AK 99501
Phone: (907) 257-2787
Email: anhc@uaa.alaska.edu

Gino Graziano
Invasive Weeds Coordinator
DNR, Division of Agriculture, NRS II
Plant Materials Center
5310 S. Bodenburg Spur Road
Palmer, AK 99645
Phone: (907) 745-8127
Email: Gino.Graziano@Alaska.gov

Fairbanks

Dr. Christa Mulder
Associate Professor in Ecology
Department of Biology and Wildlife /
Institute of Arctic Biology
University of Alaska Fairbanks
P.O. Box 756100, 211 Irving I,
Fairbanks, AK 99775
Phone: (907) 474-7152
Email: ffcpm2@uaf.edu

Katie Villano
Research Assistant
Institute of Arctic Biology
University of Alaska Fairbanks
P.O. Box 756100, 211 Irving I,
Fairbanks, AK 99775
Phone: (907) 388-5178
Email: fnklv@uaf.edu

Dr. Trish Wurtz
Invasive Plant Program Manager
USDA Forest Service, R10 S&PF
3700 Airport Way
Fairbanks, Alaska 99709
Phone: (907) 474-5994
Email: fftlw@uaf.edu

Juneau

Marie Heidemann
Juneau Office IPM Technician
Cooperative Extension Service
University of Alaska Fairbanks
1108 F St., Ste. 213
Juneau, AK 99801
Phone: (907) 796-6241
Email: fnmeh@uaf.edu

Soldotna

Janice Chumbley
Research Technician II
UAF Cooperative Extension Service
Kenai-Soldotna District
43961 K-Beach Road
Soldotna, AK 99669-9728
Phone: (907) 262-5824, x305
Email: rnjic@uaf.edu

Wasilla

Catherine Inman
Program Coordinator
Wasilla Soil & Water Conservation
District
1700 E. Bogard Rd-Ste 203A
Wasilla, AK 99654
Phone: (907) 357-4563
Email: Catherine@wasillaswcd.org

WEED WACKERS Teaching Materials Kit Supply List

In addition to a lesson guide and companion CD, *WEED WACKERS* teaching materials kits include the items on the following list. The goal of the kit is to facilitate implementation of WEED WACKERS lessons in the classroom. The materials in the kit do not include consumable items needed in the lessons such as paper towels or index cards, or items commonly available like clipboards. **Use this list as a guide to build your own *WEED WACKERS* kit for your agency or school.**

Kit Item	Quantity	Where can I get it?
Plant press	1	Hobby shop or specialty paper store
Invasive and native plant seeds	several envelopes	Hand collected and put in envelopes (or ordered from Alaska Plant Materials Center)
Pressed invasive and native plant specimen	approx. 30	Hand made with pressed plants, card stock paper, and contact paper
Sampling quadrat (collapsible: made of four 50 cm lengths of PVC pipe and four PVC 90o elbow joints)	1	Hardware store
200 ft/ 60 meter measuring tape (open reel fiberglass)	1	Forestry supply store
Soil corers (bulb planters)	6	Hardware store
Trowels	6	Hardware store
Greenhouse d-pots (d-pots 2.5" diameter x 5"deep D19L) These circular plant pots fit a soil core perfectly.	50	Stuewe and Sons Greenhouse Supplier
D-pot stand (Nova-25 tray for d-pots)	2	Stuewe and Sons Greenhouse Supplier
Leak proof greenhouse tray	2	Greenhouse supply store
Portable grow light (2 ft.flourescent growlight system)	1-2	Greenhouse supply store
Spray bottle	1	Hardware store
Petri dishes (4 inch diameter)	50	Science education supply store
Forceps	15	Science education supply store
Thermometers (range to -30^{o} C)	2	Science education supply store

Kit Item	Quantity	Where can I get it?
plastic hand lenses	25	Science education supply store
Fly swatter	6	Hardware store
Books and Pamphlets		
Alaska Exotic Plant Information Clearing House. 2005. *Invasive Plants of Alaska*. Alaska Association of Conservation Districts Publication. Anchorage, AK.	1	Local Alaska Soil and Water Conservation District office
Batten, M. 2003. *Aliens from Earth: When Animals and Plants Invade Other Ecosystems*. Peach Tree Publishers, Atlanta, Georgia.	1	Book store
Carolin, R. 2005. *Incredible Plants*. Discoveries Series. Barnes and Noble Books, New York, NY.	1	Book store
Johnson, D., L. Kershaw, A. MacKinnon, J. Pojar. 1995. *Plants of the Western Boreal Forest and Aspen Parkland*. Lone Pine Publisher, Edmonton, Canada.	1	Book store
Kudlinski, K. V. 2003. *How Plants Survive.* Chelsea Clubhouse Publishers, Philadelphia, PA.	1	Book store
Pringle, L.1995. *Fire in the Forest: A Cycle of Growth and Renewal.* Antheneum Books for Young Readers. New York, NY.	1	Book store
Royer, F., and R. Dickinson. 2004. *Weeds of Northern U.S. and Canada*. University of Alberta Press, Edmonton, Canada.	1	Book store
Sharmat, M.J. 1986. *Nate the Great Stalks Stupidweed*. Yearling Press, New York, NY. Reprinted in 2005 with added "Extra Fun Activities" by Emily Costello.	1	Book store
Souza, D.M. 2003. *Plant Invaders.* Watts Library—Scholastic Books, New York, NY.	1	Book store
University of Alaska Fairbanks Cooperative Extension Service. "Weeds: A Roadside Field Guide to Invasive and Problem Weeds for Alaska," UAF Cooperative Extension document FGV-00140. Fairbanks, AK.	30	Local Cooperative Extension office
US Department of Agriculture (USDA) Forest Service. 2007. "Selected Invasive Plants of Alaska." Pocket Guide, Anchorage, Alaska.	30	Local Alaska Soil and Water Conservation District office
Villano, K., and C. Villano. 2007. *Fire and the Changing Boreal Forest.* Mini-book with laminated cover.	1	Hand made
Watts, B. 1987. *Dandelion*. Stopwatch Book Series. Silver Burdett Press, Englewood Cliffs, NJ.	1	Book store

Help Us Improve *WEED WACKERS*

Thank you for using the *WEED WACKERS K-6 Educators Guide to Invasive Plants of Alaska* created by Katie Villano and Christine Villano. We hope you and your students feel as energized about this important conservation issue for Alaska as we do. In order to improve these materials we welcome any comments or suggestions for improvement. Please submit your comments and suggestions to cvillano@northstar.k12.ak.us or fnklv@uaf.edu, or mail the following comment sheet to *WEED WACKERS,* 2142 Bridgewater Dr., Fairbanks, Alaska, 99709.

Instructor name: _____ Email address: _____

School or Agency: _____ Town: _____

Grade level of students: _____ Number of students: _____

***WEED WACKERS* lessons used:**

Comments / Suggestions: